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Waterways Experiment Station

Airfield Pavement Evaluation, Bradshaw Army Airfield, Pohakuloa Training Area, Hawaii

by William P. Grogan

Prepared for U.S. Army Center for Public Works

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3909 Halls Ferry Road
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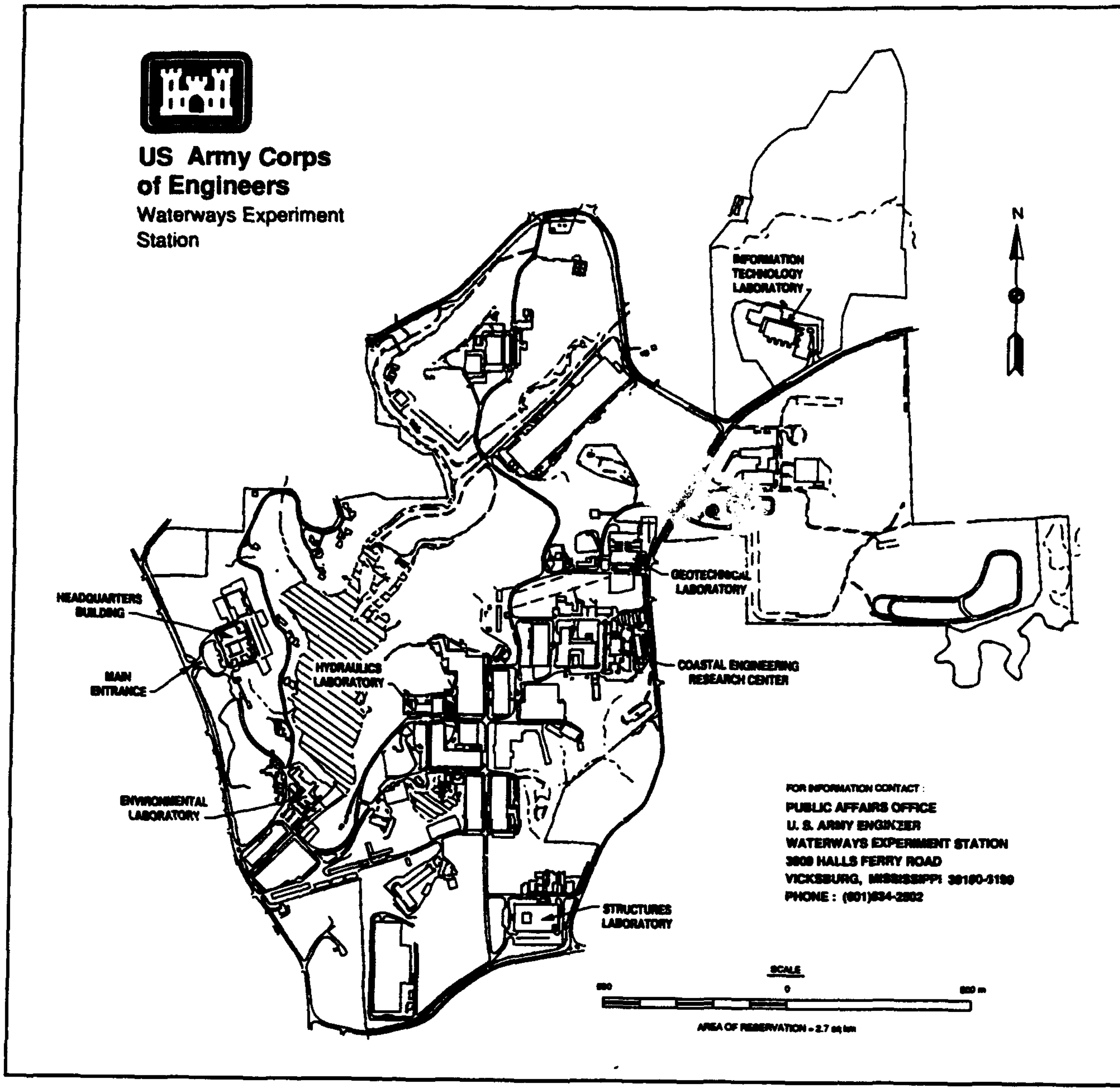

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Contents

Preface

This report provides an assessment of load-carrying capacity and condition of airfield pavements at Bradshaw Army Airfield, Hawaii. This report provides data for the following functional activities:

a. Plan and program for pavement maintenance, repairs, and structural improvements.

b. Design maintenance, repair, and construction projects.

c. Determine airfield operational capabilities.

d. Provide information for aviation flight publications and mission planning.

Users of information from this report include installation Directorate of Public Works (DPW), engineering design agencies (DPWs, U.S. Army Corps of Engineers), installation airfield Commanders, U.S. Army Aeronautical Services Agency (USAASA), and agencies assigned operations planning responsibilities. Information concerning aircraft inventory, passes and operations shall not be released outside U.S. Government agencies. This report satisfies requirement for condition inspection and structural evaluation established in Army Regulation AR 420-72 (Headquarters, Department of the Army 1991) and supports airfield survey requirements identified in AR 95-2(Headquarters, Department of the Army 1988).

The Army Airfield Pavement Evaluation (AAFEVAL) Program is managed by the U.S. Army Center for Public Works (CECPW-ER) and technically monitored by the U.S. Army Corps of Engineers Transportation Systems Center (CEMRD-ED-TT) located in Omaha, Nebraska. Funding for this airfield evaluation was provided by CECPW-ER.

This publication was prepared by the U.S. Army Engineer Waterways Experiment Station (WES) based upon pavement structural testing, and condition survey work at Bradshaw Army Airfield, Hawaii, on 24 February 1994. The survey team consisted of Messrs. William P. Grogan, Dennis Mathews, and Rogers Graham of the Pavement Systems Division (PSD), Geotechnical Laboratory (GL). Mr. Robert W. Grau, PSD, was the AAFEVAL Program Manager at WES. The publication was prepared by

Mr. Grogan under the supervision of Mr. J. W. Hall, Chief, Systems Analysis Branch, PSD, and Dr. George Hammitt II, Chief, PSD. General supervision was provided by Dr. W. F. Marcuson III, Director, GL, WES.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

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Executive Summary

The field testing at Bradshaw Army Airfield, Pohakuloa Training Area, Hawaii was conducted during February 1994 by the U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS. The structural capacity and physical properties of the pavement were determined from dynamic cone penetrometer (DCP) tests. A surface inspection of the airfield was also conducted to establish the condition of the airfield surface as opposed to its load carrying capacity.

The results of the tests and visual inspection reveal the following:

a. The airfield pavement facilities and their assigned PCN are: Runway 09-27, 36/F/A/W/T; Taxiway, 36/F/A/W/T; and Apron 27/F/A/W/T. An airfield pavement evaluation chart (APEC) showing the facilities and the PCN for each facility is shown in Figure 2-1.

b. The airfield is structurally adequate to support day to day mission requirements (i.e. peacetime use) for 20 years.

c. The surface condition of the Apron indicates that maintenance and repair (M&R) will be required. The M&R suggested in Chapter 3 should be planned now and accomplished within the next two years in order to prevent further deterioration.

d. In planning structural improvements and/or reconstruction requirements, it should be recognized that ETL 1110-3-393 (Headquarters, Department of the Army, 1988) specifies that portland cement concrete (PCC) or composite pavements with a rigid overlay be used in numerous airfield pavement areas, such as the ends of all runways, primary taxiways, and primary parking aprons.

d. Overloading the pavement facilities may shorten the life expetancy.

Additional details on structural capacity, surface condition and work required to maintain and strengthen the airfield are contained in Chapters 2 and 3 of this report.

1 Introduction

Background

In May 1982 the Department of the Army initiated a program to determine and evaluate the physical properties, the load-carrying capacity for various aircraft, and the general condition of the pavements at major U.S. Army airfields. The evaluation of the airfield pavements was performed to determine the structural adequacy of the existing pavements to accommodate mission aircraft and to identify maintenance, repair and construction work requirements.

Objective and Scope

The primary objectives of this investigation were to determine the allowable aircraft loads, and to identify maintenance, repair and structural improvement needs for each airfield pavement feature. These objectives were accomplished by:

a. Obtaining records of day-to-day traffic operations from the airfield operations personnel.

b. Performing a structural evaluation of the airfield pavements in accordance with TM 5-826-1/AFM 88-24, Chap. 1 (Headquarters, Departments of the Army and the Air Force 1988); TM5-826-2/AFM 88-24, Chap. 2 (Headquarters, Departments of the Army and the Air Force 1990), using the dynamic cone penetrometer device.

c. Performing a condition survey to determine pavement distresses (type, severity and magnitude) in accordance with TM 5-826-6/AFR 93-5 (Headquarters, Departments of the Army and the Air Force, 1989) and using analysis features of the MicroPAVER pavement management system.

The results of this study can be used to:

a. Provide preliminary engineering data for pavement design (Appendixes A and B).

b. Assist in identifying and forecasting maintenance and repair work, the preparation of long range work plans, and programming funds for the various work classification categories (Appendixes C and D).

c. Determine type and gross weights of aircraft that can operate on a given airfield feature without causing structural damage or shortening the life of the pavement structure (Appendix D).

d. Determine aircraft operational constraints as a function of pavement strength and surface condition (Appendixes C and D).

e. Determine the need for structural improvements to sustain current level of aircraft operations (Appendix D).

f. Determine the need for structural improvements to accommodate increased use of the airfield (e.g., to accommodate mobilization outloading or new aircraft mission) (Appendix D).

Chapter 2 of this report includes the results of the Aircraft Classification Number-Pavement Classification Number (ACN-PCN) analysis for use by the U.S. Army Aeronautical Services Agency (USAASA), airfield commanders, and Deputy Chief of Staff for Operations and Plans (DCSOPS) personnel. Chapter 3 contains maintenance, repair and structural improvement recommendations for use by Directorate of Public Works (DPW) personnel and design agencies. Chapter 4 contains conclusions and recommendations in summary form. Detailed, supporting data are provided in the appendices.

2 Pavement Load-Carrying Capacity

General

The load-carrying capacity is a function of the strength of the pavement, the weights of the aircraft, and the number of applications of the load. The method used to report pavement load carrying capacity is the ACN-PCN system as adopted by the International Civil Aviation Organization (ICAO). The United States as a participating member of ICAO is required to report pavement strength in this format. The ACN-PCN format also provides the airfield evaluation information required by AR 95-2(Headquarters, Department of the Army 1988).

The ACN and PCN are defined as follows: The ACN is a number which expresses the relative structural effect of an aircraft on both flexible and rigid pavements for specific standard subgrade strengths in terms of a standard single wheel load. The PCN is a number which expresses the relative load carrying capacity of a pavement for a given pavement life in terms of a standard single wheel load. An example of a PCN five part code is as follows:

```
25 /F /B /W /T
|   |  |  |  |
|   |  |  |  |
|   |  |  |  └──── PCN derived from technical evaluation
|   |  |  |
|   |  |  └──────── Tire pressure code W: High tire pressure (no limit)
|   |  |
|   |  |
|   |  └──────── Subgrade strength B: Medium (CBR 8-13)
|   |
|   └──────── Pavement type F: Flexible
|
└──── PCN = 25: Indication of load carrying capacity.
        Example C-130 loaded to 68,000 kg (150 kip)[1]
```

[1] Most of the dimensions and measurements reported were obtained in non-SI units. All such values have been converted using the conversion factors given in ASTM E 380.

The system works by comparing the ACN to the PCN. If the ACN is equal to or less than that of the PCN, the pavement is expected to perform satisfactorily for the analysis period which is typically 20 years. If the ACN is slightly higher than the PCN the pavements may be able to carry the load of the aircraft but the pavement's life will be shortened. If the ACN is significantly higher than the PCN only a few applications of that aircraft load may lead to catastrophic failure of the pavement.

Load-Carrying Capacity

The first step in determining the load carrying capacity of the pavements at Bradshaw Army Airfield (BAAF), Pohakuloa Training Area, Hawaii was to estimate the traffic the airfield will be subjected to over the next 20 years. The base operations personnel at BAAF provided a record of the aircraft activity operating on BAAF during the 1993 calendar year. The data provided did not specify aircraft operations, but did specify flight plans filed. Discussions with base operations personnel indicated that assuming that all flight plans submitted were C-130's would be adequately conservative for this evaluation. A total of 739 flight plans were processed in 1993. Projecting this for 20 years results in approximately 15,000 operations of a C-130, the critical aircraft, to be used for the evaluation of the airfield pavements. The airfield consists of one AC runway, one AC taxiway, and one AC apron (as shown in Figure 2-1); therefore all features were evaluated for 100 percent of the projected traffic.

Using the traffic information, results of the data analysis,and information from previous reports the ACN values for the critical aircraft operating on the BAAF pavements were determined. These values are designated as the operational ACN. For the pavement facilities at BAAF, the operational ACN is 24/F/A/W/T for the flexible pavements. There are no rigid pavements at BAAF. (See Table D5 for a description of the five component ACN or PCN code). The numerical ACN values calculated for the critical aircraft operating on AC and PCC pavements on each of the four subgrade categories are presented in Table D1.

The critical PCN value for each airfield facility is presented in the Airfield Pavement Evaluation Chart (APEC) which is presented in Figure 2-1. A summary of allowable loads and overlay requirements determined for the critical aircraft and its design pass level is shown in Table D3. This Table shows that the load carrying capacities of the primary features are capable of sustaining the mission traffic over the 20 year analysis period.

The number of passes of mobilization and contingency aircraft loadings that could be sustained by each facility is dependent on the ACN of the aircraft and the critical PCN of the facility. During wartime, many aircraft are allowed to carry heavier loads than during peacetime. This means that the aircraft would have a higher ACN because of the higher loading and would cause more damage per pass than in peacetime. Also under some contingency plans or during

plans or during emergencies, heavier aircraft than the critical aircraft, a 70,300 Kg (155-kip) C-130, could be considered for using the airfield pavements. These aircraft would generally have higher ACN values and cause more damage than those normally using the airfield. The operational life of the pavement will be reduced if it is subjected to aircraft loadings having higher ACN values than the PCN of the facility. Appendix D contains an example of a procedure to determine the impact of mobilization and contingency aircraft operations.

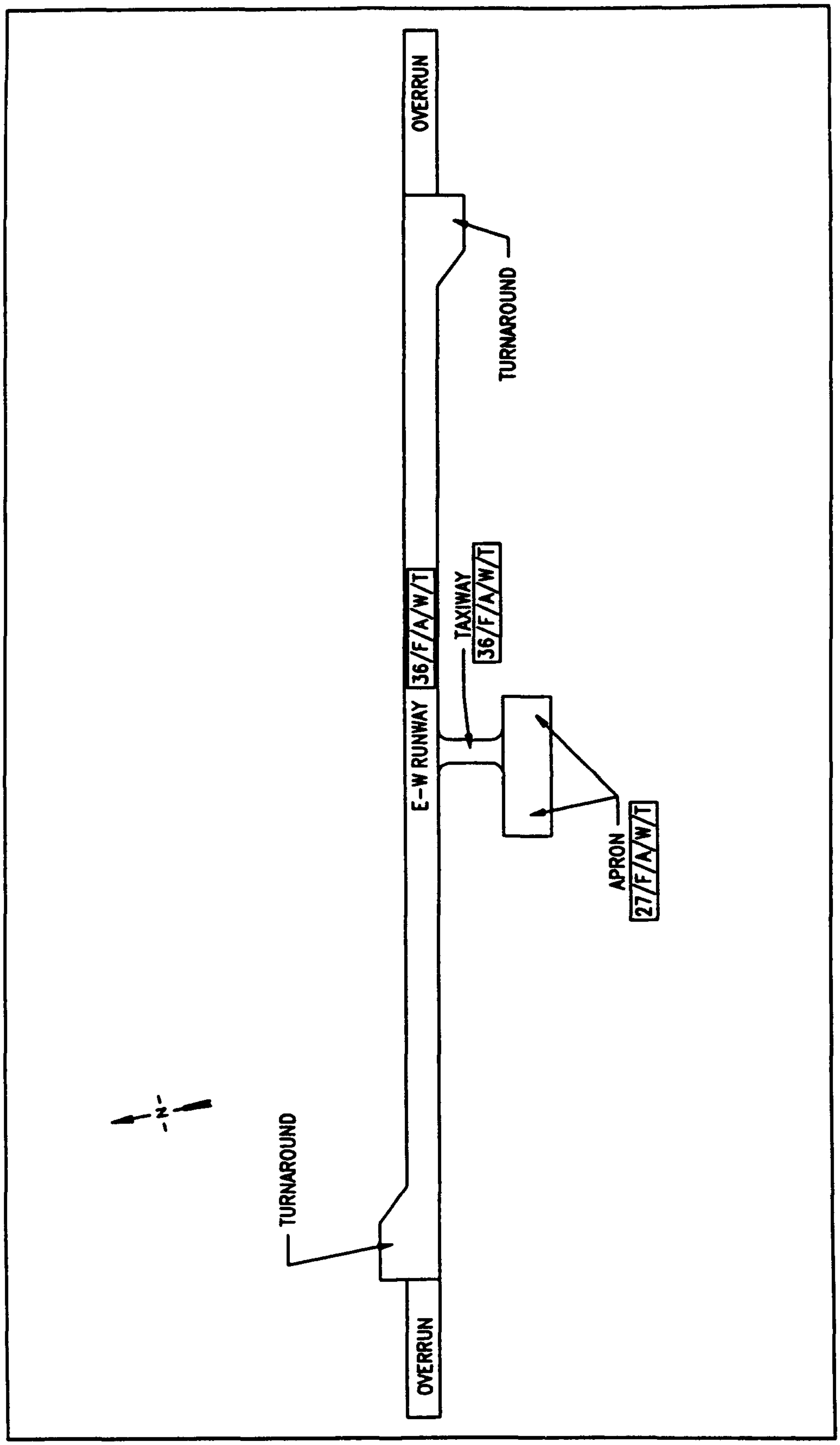

Figure 2-1. Airfield pavement evaluation chart (APEC)

3 Recommendations for Maintenance, Repair, and Structural Improvement

General

Recommendations for maintenance, repair and structural improvements are based on results from both the structural evaluation (Appendix D) and the pavement condition survey (Appendix C). Either or both the evaluation or the survey may indicate a particular feature needs repair and/or improvement. In general if the PCI is below the required values contained in AR 420-72 (Headquarters, Department of the Army 1991) the pavement needs maintenance to improve its surface condition. If the ACN/PCN ratio determined for the critical aircraft is greater than one the pavement needs structural improvement. Where both evaluations indicate improvements are needed the recommendations are made such that the repairs to the surface are those needed until the structural improvements can be made. If the structural improvements are made first, the surface repairs may not be necessary. The PCI, ACN/PCN and recommended general maintenance alternatives for each feature are shown in Table 3-1 the Airfield Pavement Evaluation General Summary. Specific recommendations are identified in Table 3-2.

Recommendations for structural improvements, if required, are defined in terms of overlays in this report. In some instances overlays may not be the most cost effective or best engineering alternative for pavement strengthening. It should be noted that the evaluation results shown in Table 3-2 were determined based on representative conditions at the time of testing and should be considered minimum values until verified by further investigation. Prior to advertising an improvement project, a thorough pavement analysis and design should be completed to select the most cost effective improvement technique. All designs should be reviewed by CEMRD-ED-TT to ensure that they are in accordance with current design criteria.

When overlays are determined to be necessary, the recommended overlay thicknesses follow the criteria for minimum thickness contained in TM 5-825-3/AFM 88-6, Chap. 3 (Headquarters, Departments of the Army and the Air Force 1988). If calculated thicknesses are greater than the minimum thicknesses, the values were rounded up to the next higher one-half inch.

Maintenance and repair (M&R) recommendations are based on the changes needed to provide the minimum required PCI. AR 420-72 (Headquarters, Department of the Army 1991) establishes those requirements at 65 to 75 for all runways and primary taxiways and 40 to 55 for aprons and secondary taxiways.

Recommendations

Steps 1 through 5 of the flow chart shown in Figure 3-1 were used in determining the recommendations suggested in Table 3-2. The M&R alternatives suggested for the existing surfaces were selected from those listed for various distresses in AC pavements shown in Table 3-3. In many instances, the performance of a specific alternative depends upon the geographical location and expertise of local contractors. Therefore, it is suggested that the local DPW personnel review all recommendations. Local costs for the approved alternatives can then be used with the Micro Paver program to obtain a reasonable cost estimate. All overlay, repair, or construction should be in accordance with ETL 1110-3-393 (Headquarters, Department of the Army, 1988) which required PCC at runway ends and for the primary taxiway and parking apron systems. The features in Table 3-2 marked with " [3] " require a PCC surface if reconstructed.

The PCI was developed to determine maintenance and repair needs. If the PCI is low, maintenance or repair is needed to increase the PCI. If the PCI is low and the PCN is greater than the ACN, localized maintenance or repair will generally be an acceptable solution. Although these maintenance activities and repairs will improve the PCI to acceptable levels, this does not mean that this is the most cost-effective alternative. An overlay or other overall improvement may be more cost-effective than considerable localized maintenance or repairs. Certainly, if the current PCI is less than 25, overall improvements should be investigated. When an overlay is recommended, the maintenance recommended is that needed to keep the pavement serviceable until the overlay is applied. Although these recommendations will raise the PCI, this does not insure that the improved PCI will remain above the minimum levels for the analysis period. The PCN and the ACN were developed to determine the capability of an airfield pavement to safely support different aircraft. If an improvement is needed to increase the PCN to the ACN and only repairs to improve the PCI are applied, the pavement will probably deteriorate quite rapidly under traffic. If the PCN is lower than the ACN, the pavement needs an improvement to increase the load carrying capacity so that the PCN will be greater than or equal to the ACN. In some cases, the PCI may be high while the PCN is lower than the ACN. In this case, the pavement needs an improvement to increase the load carrying capacity of the pavement.

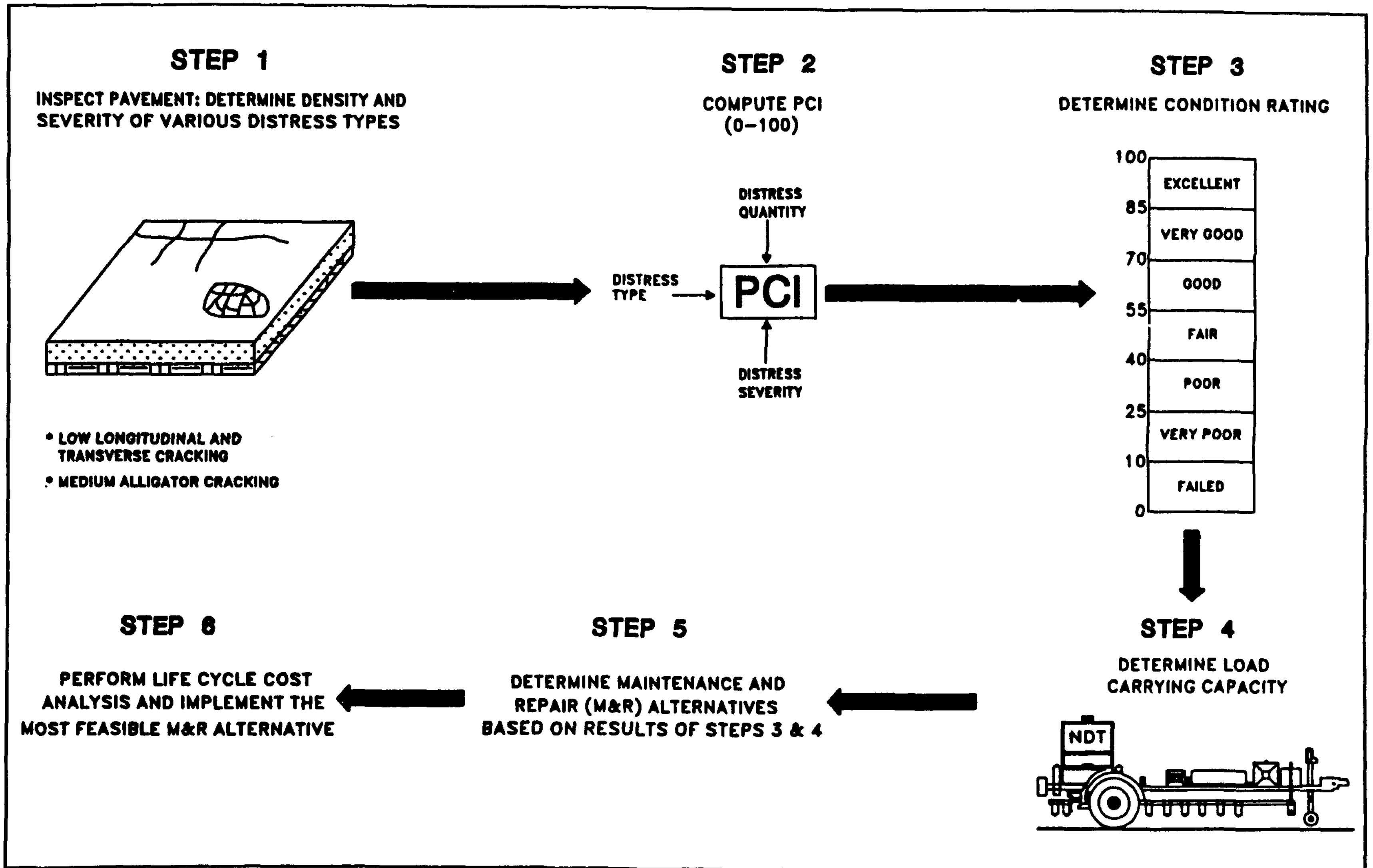

Figure 3-1. Flowchart for determination of maintenance and repair alternatives

Table 3-1
Airfield Pavement Evalaution General Summary[1]

Pavement Feature	PCI	ACN/PCN[2]	Recommendations			
			Do Nothing	Maintenance	Repair	Construction
R1E	99	0.7	X			
R2E	96	0.7	X			
R3E	100	0.7	X			
T1E	98	0.7	X			
A1E	77	0.9		X		

[1] Work is categorized for preliminary planning purposes only. Classification of work for administrative approval is an installation responsibility. Policy guidance for airfield pavements is provided in AR 420-72. In general, if the pavement real property facility is in a failed or failing condition, structural improvements to accommodate normal growth and evolution of missions and equipment are properly classified as repair work. The following types of work are properly classified as construction: strengthening of a pavement to accommodate a new mission, extension or widening of the pavement, or complete replacement of the real property facility. Refer to AR 420-72 for specific guidance.
[2] Determined for design aircraft during the non-frost period.

Table 3-2
Summary of Overlay and Maintenance Requirements for the Day-to-Day Traffic Operations

Feature	Area sq m (sq yd)	Overlay Requirements, cm (in.)[1]			Maintenance and Repair Alternatives for Existing Surfaces
		AC	PCC	PCC with Bond Breaker	
Runway 09-27					
R1E[3]	3,760 (4,500)	0.0	---	---	No action is required at this time. The condition of this facility should be monitored and any increase in distress quantity should be investigated.
R2E[3]	25,920 (31,000)	0.0	---	---	No action is required at this time. The condition of this facility should be monitored and any increase in distress quantity should be investigated.
R3E[3]	3,760 (4,500)	0.0	---	---	No action is required at this time. The condition of this facility should be monitored and any increase in distress quantity should be investigated.
Taxiways					
T1E[3]	1,280 (1,530)	0.0	---	---	No action is required at this time. The condition of this facility should be monitored and any increase in distress quantity should be investigated.
Aprons					
A1E[3]	5,850 (7,000)	0.0	---	---	Clean and seal low and medium severity cracks.

[1] For planning purposes only.
[2] See TM 5-822-11/AFP 88-6, Chap. 7 (Headquarters, Departments of the Army and the Air Force, 1992) for guidance.
[3] ETL 1110-3-393 requires that the surface be PCC.

Table 3-3
Maintenance, Repair, and Construction Alternatives for Airfield Pavements, Flexible

	Maintenance				Repair												Construction		
Distress Type	Seal Minor Cracks	Repair Potholes	Partial-Depth Patching	Apply Rejuvenators[1]	Seal Major Cracks	Full-Depth Patching	Surface Treatment[2]	Slurry Seal[3]	Thin AC Overlays[4]	Surface Milling	Grooving	Porous Friction Course	Repair Drainage Facilities[5]	Surface Recycling	AC Structural Overlay[4]	PCC Structural Overlay	Remove Existing Surface and Reconstruct	Hot Recycle	Cold Recycle
Alligator cracking	L	M,H	M			M,H	L	L					L,M,H		M,H	M,H	H		
Bleeding										L,M				M,H			H	M,H	M,H
Block cracking	L,M			L	M,H		L,M	L						M	M,H			M,H	M,H
Corrugation			L,M			L,M,H			M,H	L,M							M,H		
Depression			L,M,H			M,H			M,H				L,M,H				H		
Jet blast				A		A			A										
Reflection cracking	L,M				M,H		L,M	L							M,H			H	
Longitudinal and transverse cracking	L,M				M,H		L,M	L							M,H			H	
Oil spillage			A			A			A	A				A			A	A	
Patching	L,M		M		M	M,H									M,H		H	H	
Polished aggregate							A	A	A	A	A	A		A					
Raveling/weathering		M,H		L,M		M	L,M	L	M,H	M				M,H		H	H	M,H	
Rutting			L,M			L,M,H							L,M,H		M,H	H	H	M,H	
Shoving			L			L,M				L,M							M,H	M,H	
Slippage cracking	L		L,M		L,M	M,H									M,H		M,H	M,H	
Swell			L,M			M,H				L,M			L,M,H				H		

Note: L = low severity level; M = medium severity level; H = high severity level; A = no severity levels for this distress.
[1] Not to be used on high speed areas due to increased skid potential.
[2] Not to be used on high-type airfields due to FOD potential.
[3] Not to be used on heavy traffic areas.
[4] Patch distressed areas prior to overlay.
[5] Drainage facilities to be repaired as needed.

4 Conclusions

General

The results of the evaluation in Table 3-2 were determined based on representative conditions at the time of testing. It should be noted that the CBR values, based on the results of the DCP testing, determined for the various pavement layers can deviate throughout the year. Therefore, it is recommended that before specific structural improvements are programmed, a thorough pavement analysis and design be completed to select the most cost-effective improvement technique. To be in accordance with ETL 1110-3-393 (Headquarters, Departemnt of the Army, 1988) all of the features at BAAF are required to have a PCC surface if structural improvements are planned.

The maintenance and rehabilitation alternatives discussed in Chapter 3 and summarized in Table 3-2 should be performed as soon as possible to retain the full benefit of the structural capacity of the existing pavement. The maintenance and repair alternatives suggested for the existing surfaces were selected from those listed for the various distresses shown in Table 3-3. In many instances the performance of a specific alternative is dependent upon local conditions and contractors.

The operational ACN for the pavement facilities at BAAF is 24/F/A/W/T.

Structural Capacity and Condition Ratings

Runway 09-27

All features of Runway 09-27 should withstand the 20-year projected day-to-day operations. At a minimum, routine maintenance should be performed on all the pavement features to insure maximum performance.

The PCN for runway 09-27 is 36/F/A/W/T. The general condition rating of Runway 09-27 is excellent.

Taxiway

The taxiway should, with routine maintenance, withstand the 20-year projected day-to-day operations.

The PCN for the taxiway is 36/F/A/W/T. The general condition rating of the taxiway is excellent.

Apron

The Apron should, with routine maintenance, withstand the 20-year projected day-to-day operations.

The PCN for the apron is 27/F/A/W/T. The general condition rating of the apron is very good.

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Appendix A
Background Data

Description of the Airfield

BAAF is located on Pohakuloa Training Area, Hawaii, approximately 48 km (30 mi) northwest of Hilo, HI. In February 1994, the airfield consisted of one AC runway with a perpendicular AC taxiway and an AC apron.

A layout of the airfield pavements is shown in Figure A1. Runway 09-27 is 27 m (90 ft) wide and 1127 m (3,700 ft) long. The airfield is located near the center of the island of Hawaii. The elevation of the airfield is at 1886 m (6189 ft) mean sea level.

Previous Reports

Pertinent data for this airfield were extracted from a previous evaluation report (U.S. Army Engineer Division, Pacific Ocean, "Pavement Evaluation for Bradshaw Army Airfield, Pohakuloa Training Area, Hawaii," January 1981, Fort Shafter, Hawaii) for use in this report.

Design and Construction History

The original runway pavement at BAAF is believed to have been constructed in the early 1950's. The taxiway and apron were constructed in 1958. Accurate construction records of the initial construction are not available. In 1965, extensions to the apron were constructed. In 1979 the airfield was upgraded to support the operation of C-130 aircraft. The upgrading included the construction of an asphalt concrete inlay for the keel section of the runway, the addition of turnarounds to both ends of the runway, and a complete reconstruction of the taxiway. Those pavements not newly or reconstructed received a 4 cm (1.5 in) asphalt concrete overlay. Table A1 presents the history of the major construction activities at BAAF. Table A2 contains a summary of the physical property data of the various features. The

locations of the various pavement features can be determined from Figure A2. Figure A3 shows typical foundation and pavement sections.

The major construction projects as BAAF are summarized as follows:

a. *1950-1955 construction.* The only facility constructed during this period was runway 09-27.

b. *1958 construction.* The taxiway and apron were constructed.

c. *1965 construction.* Extensions to the apron were constructed to the east and west.

d. *1979 construction and reconstruction.* A 8 cm (3 in) AC overlay was constructed in the keel section (center 12 m (40 ft)) of the runway, and a 4 cm (1.5 in) AC overlay was constructed on edges of the runway. Turnarounds with 8 cm (3 in) of AC surface were constructed at each end of the runway. The taxiway was reconstructed with a 8 cm (3 in) AC surface. The center portion of the apron recieved a 8 cm (3 in) overlay, the east and west ends of the apron received 4 cm (1.5 in) AC overlays.

Traffic History

Airfield activity records were obtained from base operations personnel at BAAF for the 1993 calendar year. The 1993 records were used to project the traffic the airfield would be expected to support for the next 20 years. From the data provided by the operations personnel, the 20 year day-to-day operations to be used for evaluation was determined to be 15,000 passes of a 70,300 Kg (155-kip) C-130.

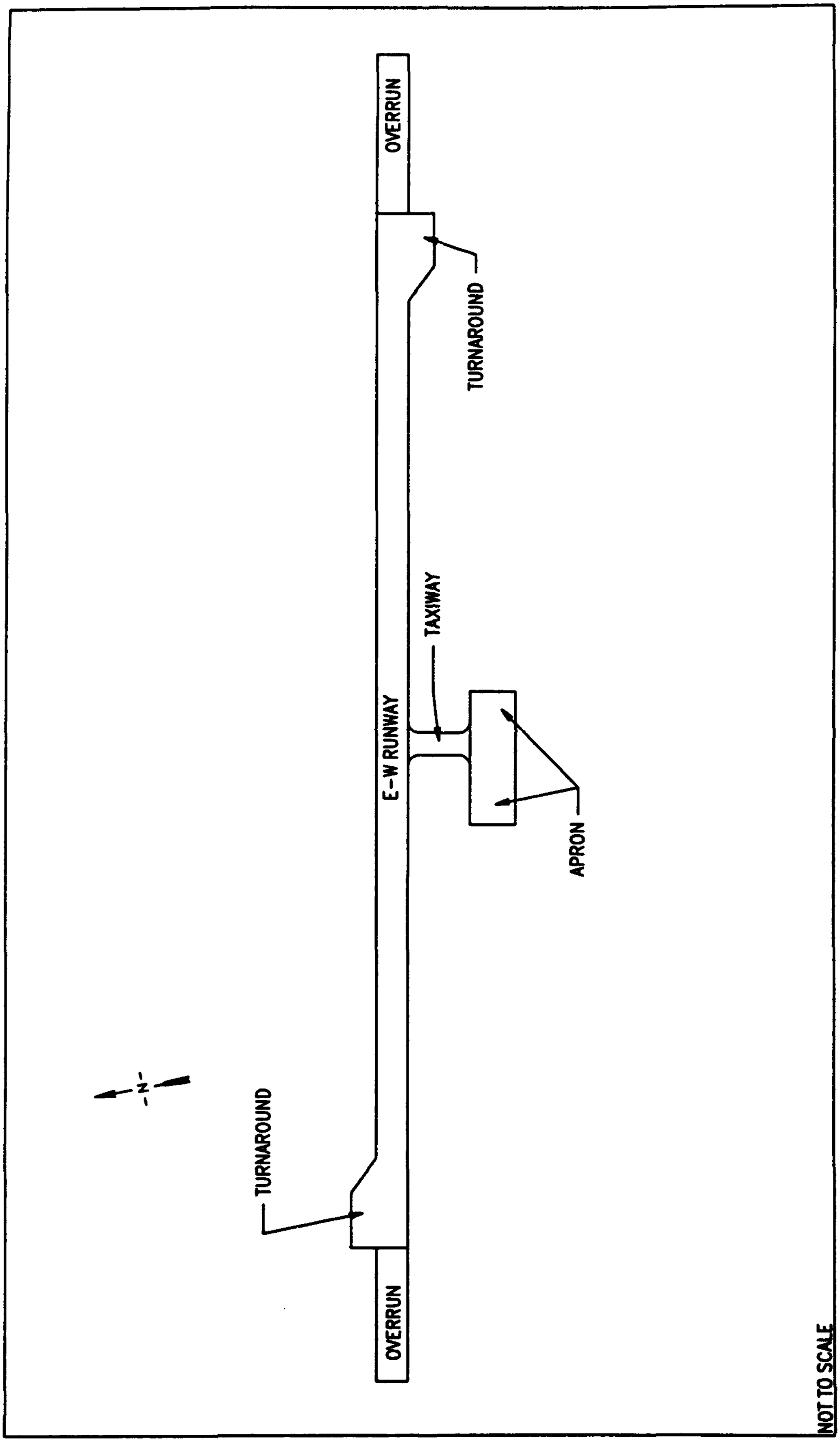

Figure A1. Layout of airfield pavements and facility identification

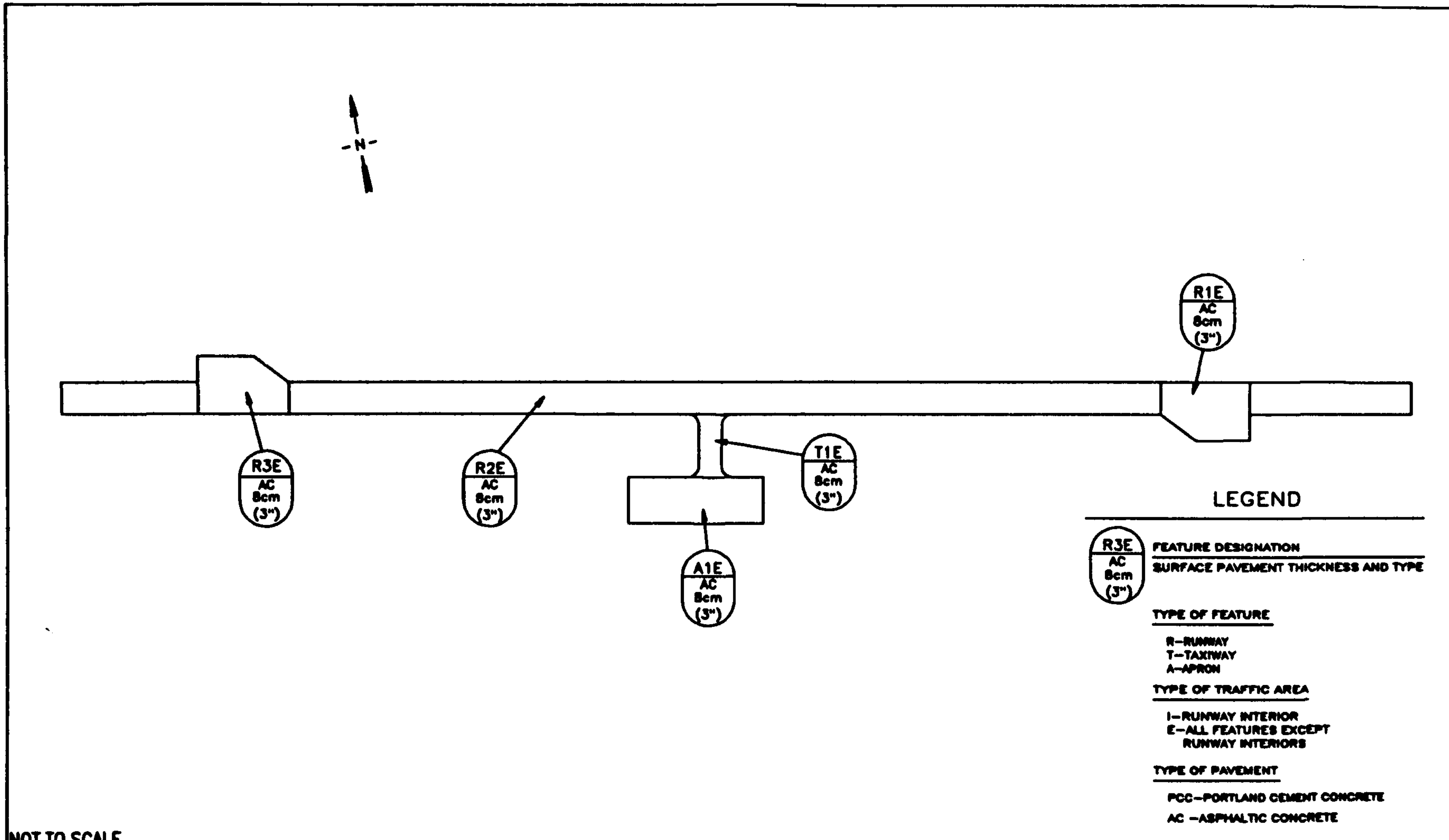

Figure A2. Pavement feature identification and locations at WAAF

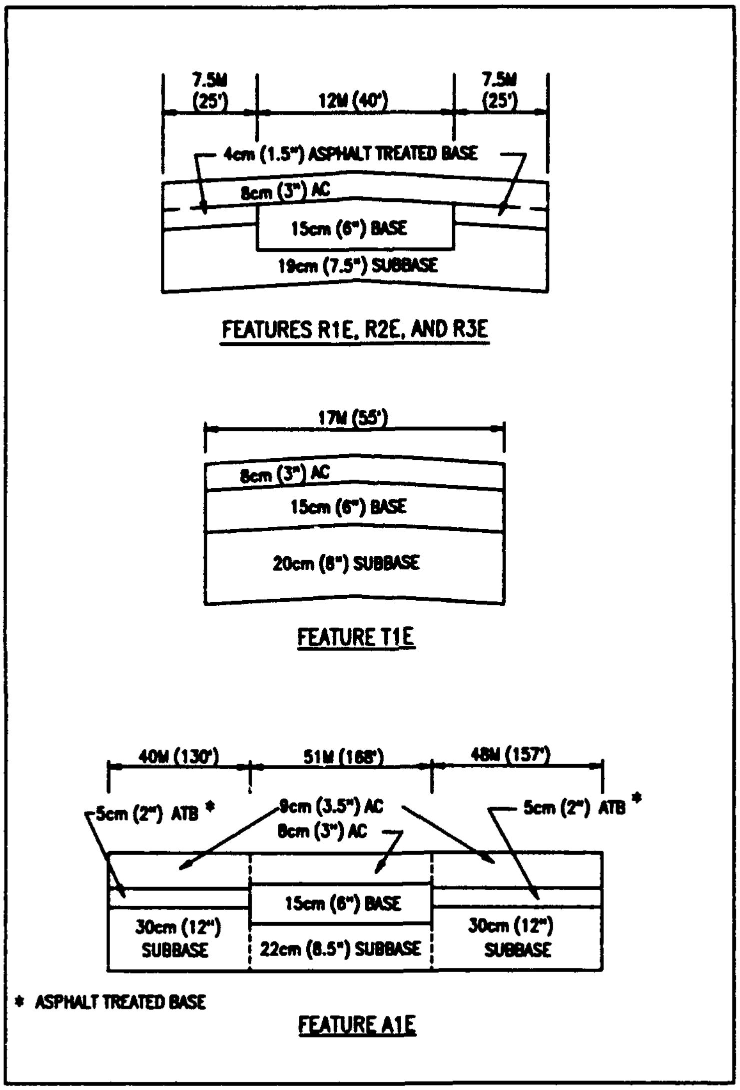

Figure A3. Typical pavement foundation sections

Table A1
Construction History

Pavement Facility (Feature)	Pavement		Construction Date
	Thickness, cm (in.)	Type	
Runway 09-27 (R1E, R2E, R3E)	4 (1.5) 8 (3)	ATB[2] AC[1]	1950-55 1979
Taxiway (T1E)	4 (1.5) 8 (3)	ATB[2] AC	1958 1979 (ATB removed)
Apron (A1E)	5 (2) 8 (3)	ATB[2] AC	1958 1979 (ATB removed)
Apron Extensions (A2E, A3E)	6 (2.25) 4 (1.5)	AC AC[1]	1965 1979

[1] Overlay Pavement.
[2] Asphalt Treated Base.

Table A2
Summary of Physical Property Data

FACILITY				OVERLAY PAVEMENT			PAVEMENT			BASE			SUBBASE			SUBGRADE	
FEATURE	IDENTIFICATION	LENGTH m (ft)	WIDTH m (ft)	THICKNESS cm (in)	DESCRIPTION	FLEX. STR. MPa (PSI)	THICKNESS cm (in)	DESCRIPTION	FLEX. STR. MPa (PSI)	THICKNESS cm (in)	DESCRIPTION	CBR K MN/m³ (pci/in)	THICKNESS mm (IN.)	DESCRIPTION	CBR	DESCRIPTION	CBR K MN/m³ (pci/in)
R1E	Runway 09-27	91 (300)	55 (180)				8 (3)	AC		152 (6)	Stabilized Aggregate	80	19 (7.5)	Cinder Gravel	50	Silty Sand (SM)	15
R2E	Runway 09-27	945 (3,100)	27 (90)				8 (3)	AC		152 (6)	Stabilized Aggregate	80	19 (7.5)	Cinder Gravel	50	Silty Sand (SM)	15
R3E	Runway 09-27	91 (300)	55 (180)				8 (3)	AC		152 (6)	Stabilized Aggregate	80	19 (7.5)	Cinder Gravel	50	Silty Sand (SM)	15
T1E	Taxiway	76 (250)	17 (55)				8 (3)	AC		152 (6)	Stabilized Aggregate	80	20 (8.0)	Cinder Gravel	50	Silty Sand (SM)	15
A1E	Apron	137 (450)	43 (140)				8 (3)	AC		152 (6)	Stabilized Aggregate	80	22 (8.5)	Cinder Gravel	50	Silty Sand (SM)	15
Overrun	09 End Overrun	152 (500)	27 (90)				1 (0.5)	AC		—	—		—	—		Silty Sand (SM)	30
Overrun	27 End Overrun	152 (500)	27 (90)				1 (0.5)	AC		—	—		—	—		Silty Sand (SM)	30

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Appendix B
Tests and Results

Tests Conducted

The pavements were evaluated based on the results from dynamic cone penetrometer (DCP) tests. The test procedures and results are discussed below.

Dynamic Cone Penetrometer Tests

A DCP soil test device was used to obtain subsurface soil data at representative locations. The DCP is a steel cone attached to the end of a metal rod on the other end of which is located an 8 kg (17.6-lb) sliding drop-hammer. For this investigation a small hole was cored through the AC material. The cone of the DCP was then placed on top or near the top of the base and the hammer was then dropped repeatedly to drive the cone through the underlying pavement layers. The material resistance to penetration was recorded in terms of millimeters penetrated per hammer blow. California Bearing Ratio (CBR) was then determined based on a correlation and procedure recommended in (Webster, Grau, and Williams 1992). DCP tests were performed at select locations of BAAF as shown in Figure B1. The results of the DCP tests are best illustrated on a plot of CBR versus depth for each test location. Figures B2 through B9 show these data for the tests performed on the facilities. It should be noted that when analyzing the DCP data, the regression equation used to backcalculate the CBR may indicate a CBR value greater than 100 percent. A CBR of 100 percent is considered the maximum (see DM21.3/TM 5-825.2/AFM 88-6 Chap.2). Any backcalculated CBR greater than 100 percent was plotted as 100 percent in Figures B2 through B9 and considered 100 percent for evaluation purposes.

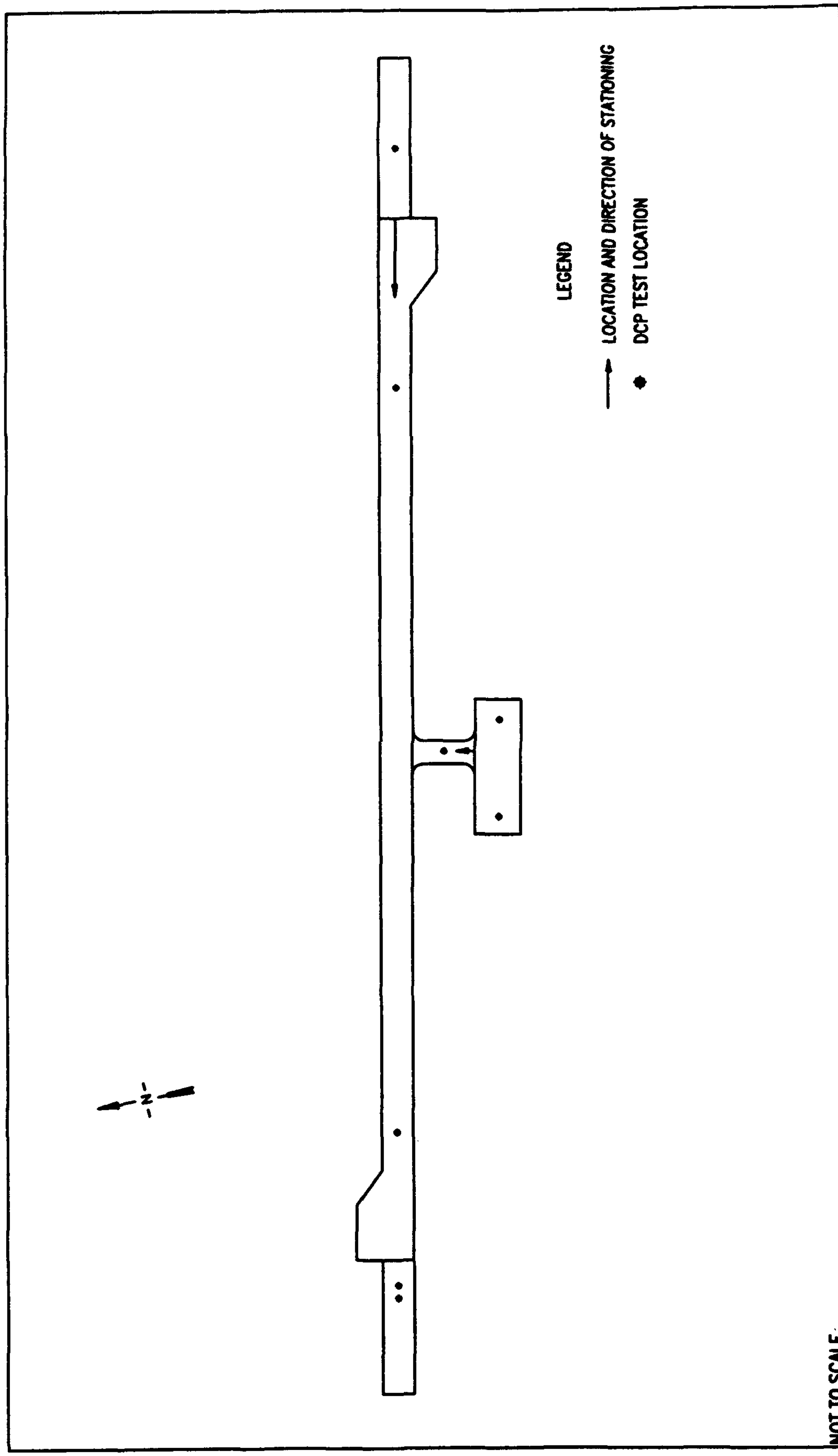

Figure B1. DCP test locations at BAAF

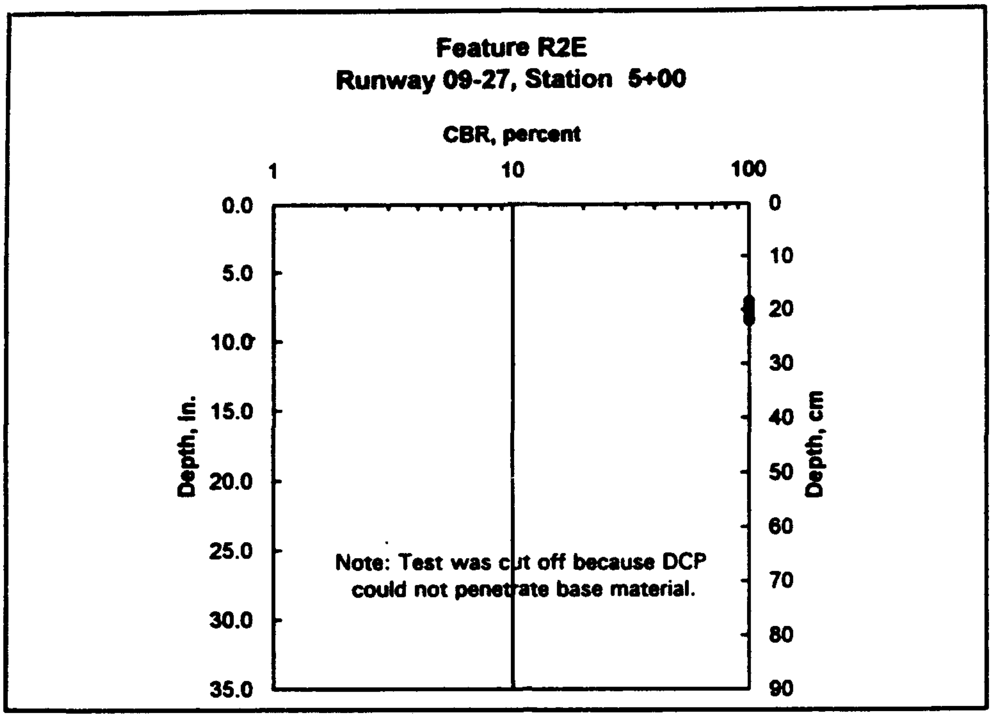

Figure B2. DCP results, Runway 09-27, Station 5+00

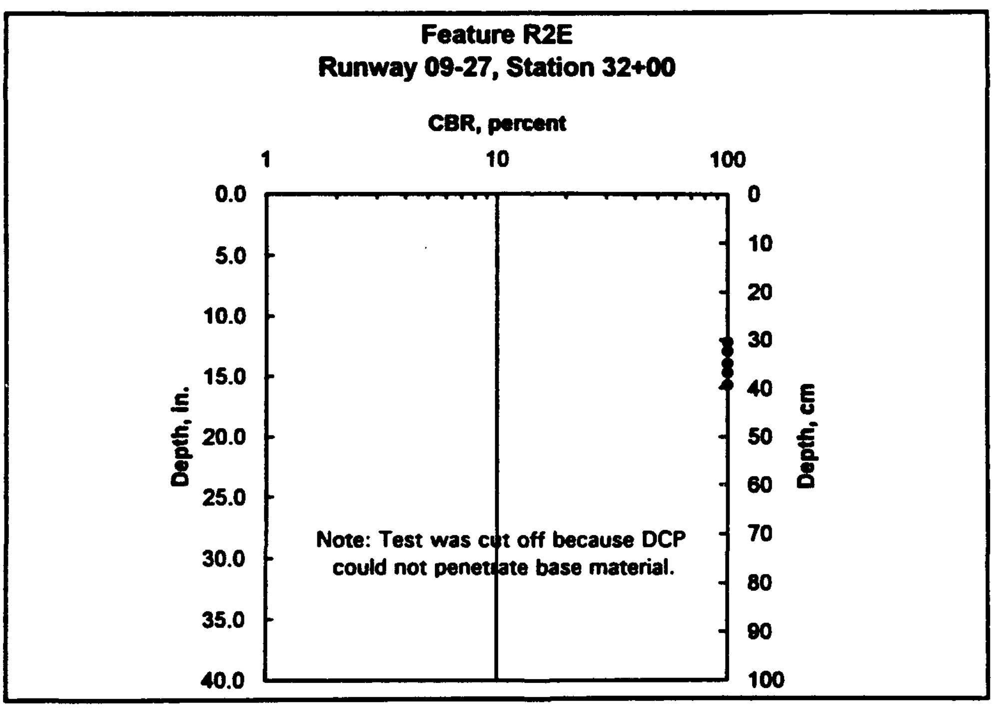

Figure B3. DCP results, Runway 09-27, Station 32+00

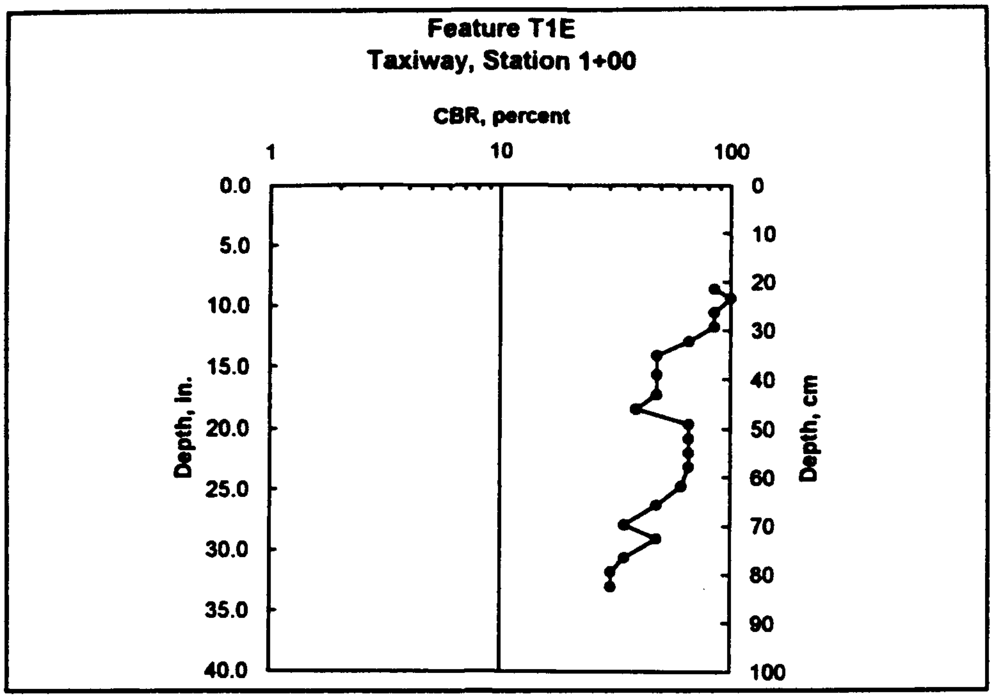

Figure B4. DCP results, Taxiway, Station 1+00

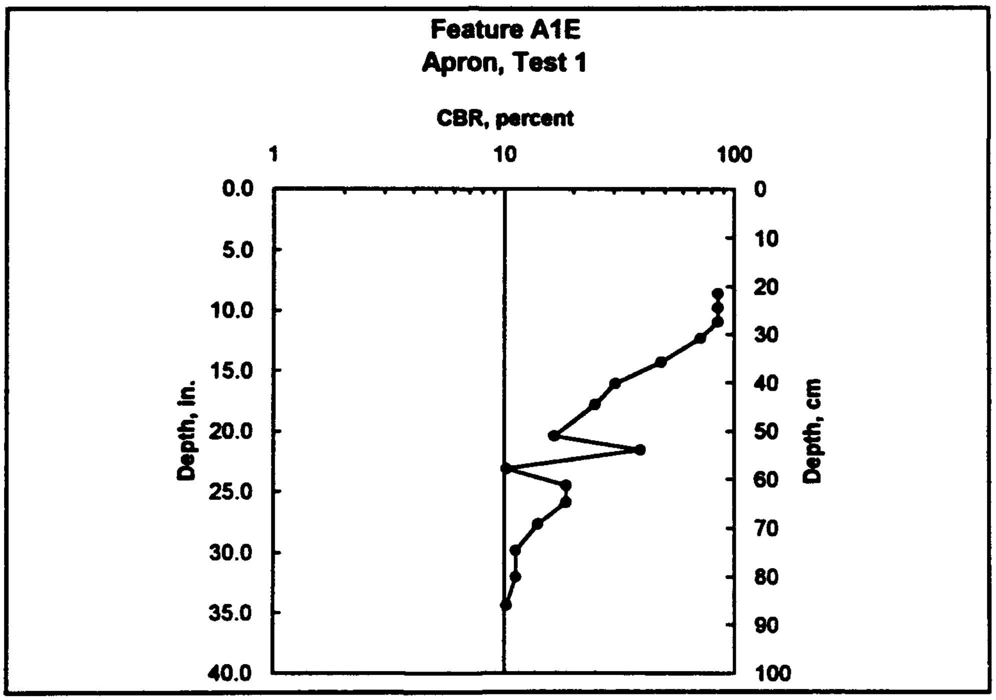

Figure B5. DCP results, Apron, Test 1

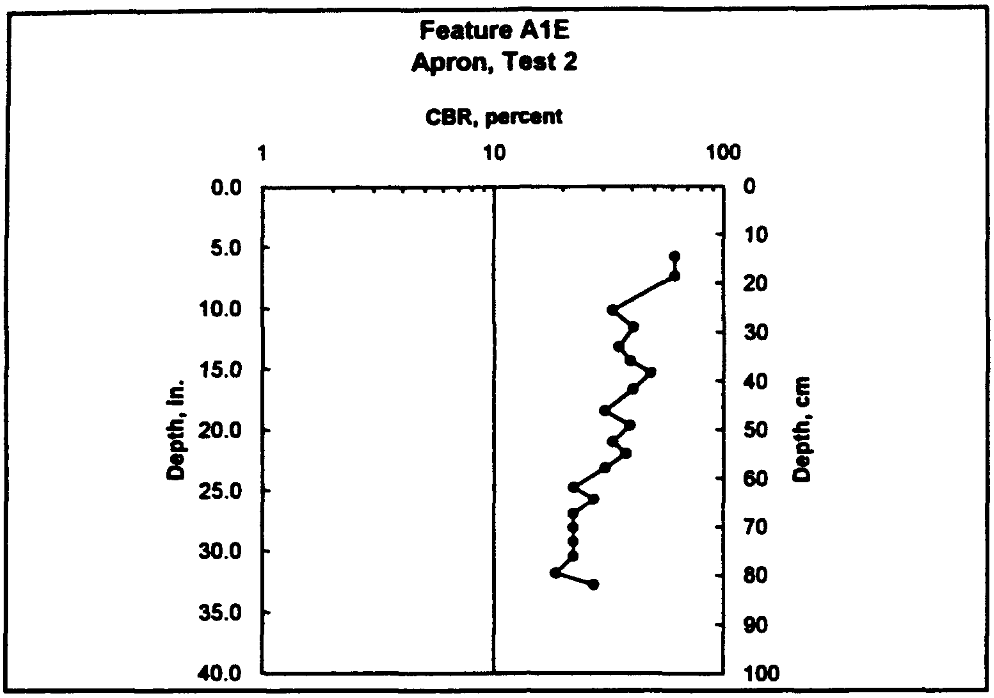

Figure B6. DCP results, Taxiway, Test 2

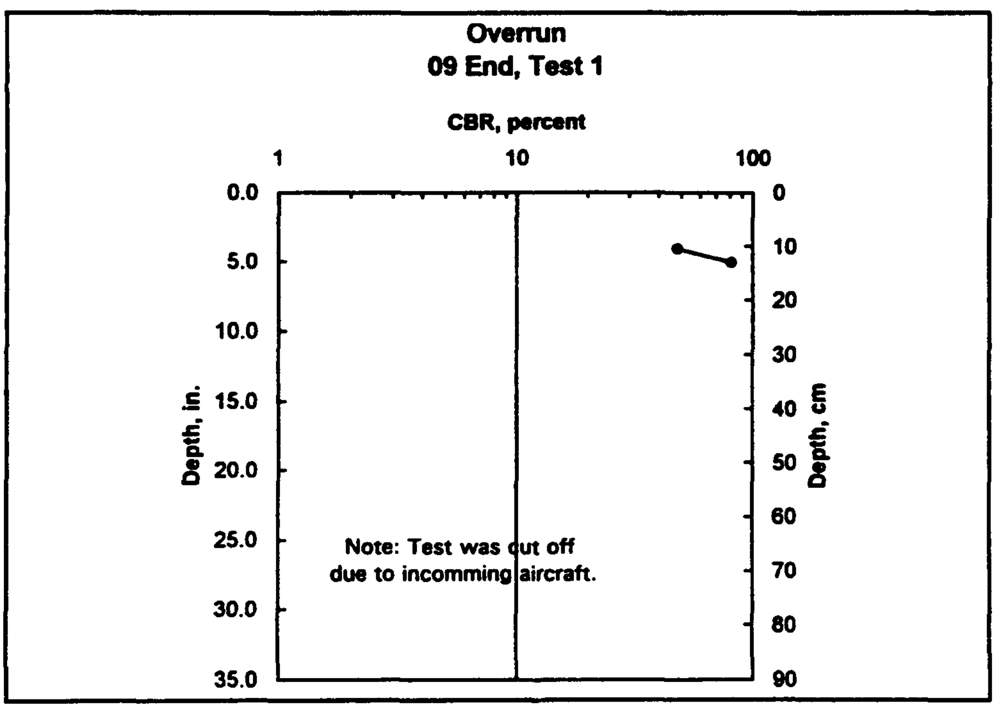

Figure B7. DCP results, 09 End Overrun, Test 1

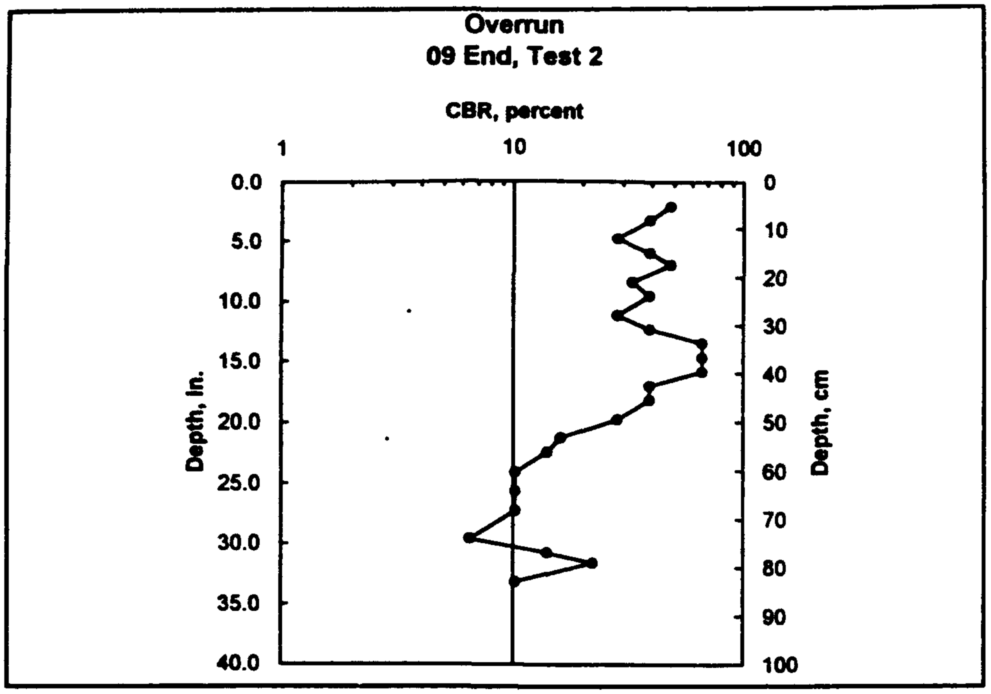

Figure B8. DCP results, 09 End Overrun, Test 2

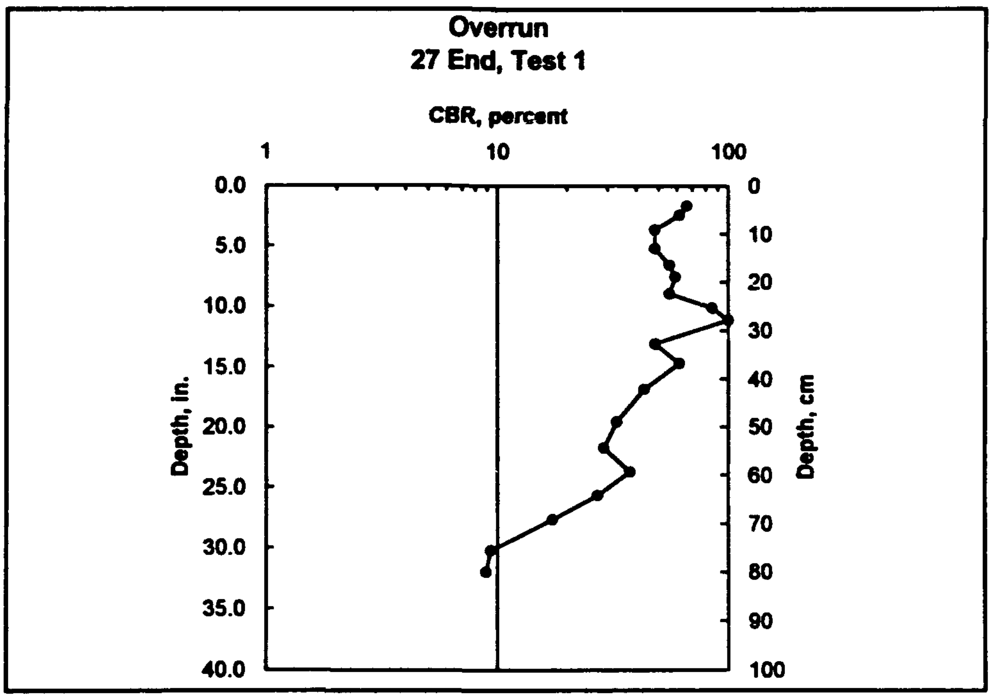

Figure 9. DCP results, 27 End Overrun

Appendix C Pavement Condition Survey and Results

Pavement Condition Survey

A pavement condition survey is a visual inspection of the airfield pavements to determine the present surface condition. The condition survey consists of inspecting the pavement surface for the various types of distresses, determining the severity of each distress, and measuring the quantity of each distress. The condition survey provides estimated quantities of each distress type and severity from which the pavement condition index (PCI) for each feature can be determined. The PCI is a numerical indicator based on a scale from 0 to 100 and is determined by measuring pavement surface distress that reflects the surface condition of the pavement. Pavement condition ratings (from excellent to failed) are assigned to different levels of PCI values. These ratings and their respective PCI value definitions are shown in Figure C1. The distress types, distress severities, methods of survey, and PCI calculation are described in TM 5-826-6/AFR 93-5 (Headquarters, Departments of the Army and the Air Force 1989).

Condition survey procedure

The PCI and estimated distress quantities are determined for each feature. The information is based on inspection of a selected number of sample units. Sample units are subdivisions of a feature used exclusively to facilitate the inspection process and reduce the effort needed to determine distress quantities and the PCI. Each feature was divided into sample units. The sample units for the AC pavement features were approximately 465 sq m (5000 sq ft). The statistical sampling technique was used to determine the number of sample units to be inspected to provide a 95 percent confidence level. Sample units were chosen along the center line of the runway and taxiway and were chosen randomly on the apron. The stationing and direction of survey are shown in Figure B1. The locations of the sample units on the apron are shown in Figure C2. After the sample units were inspected, the mean PCI of all sample units within a feature was calculated and the feature was rated as to its condition: excellent, very good, good, fair, poor, very poor, and failed.

Analysis of PCI Data

The distress information collected during the survey were used with the Micro Paver program to estimate the quantities of distress types for each feature. This information is presented along with the PCI, general rating, and distress mechanism (load, climate, or other) in Appendix ⁻.. The major distress types observed on the AC pavements were longitudinal and transverse cracking, bleeding and oil spillage.

AR 420-72 (Headquarters, Department of the Army 1991) requires that all airfield pavements be maintained at or above the following PCI ranges:

All runways and primary taxiways, 65 to 75.
All aprons and secondary taxiways, 40 to 55.

Recommendations to apply maintenance or repair to improve existing PCI values are presented in Table 3-2. These were developed based on a decision process by which the pavement engineer can select from multiple alternatives after giving consideration to the surface condition and structural capacity of the pavement feature. In this process, both the PCI condition rating and structural rating are required. The results of these two ratings are used to follow a flowchart that allows the determination of the most appropriate work classification category (maintenance, repair, or construction). The recommendations shown in Table 3-2 were selected from maintenance, repair, and construction alternatives suggested for various distresses. The alternatives are shown in Table 3-3. In many instances, the performance of a specific alternative depends upon the geographical location and expertise of local contractors. Therefore, it is suggested that the local DPW personnel review all recommendations. Local costs for the approved alternatives can then be used with the Micro PAVER program to obtain a reasonable cost estimate. All structural improvements or construction should be in accordance with ETL 1110-3-393 (Headquarters, Department of the Army 1988) which requires PCC or composite pavements with PCC overlay at runway ends and for the primary taxiway and parking apron systems.

Condition survey results

A summary of the pavement condition survey results is shown in tabular form in Table C1. Table C1 lists the sample unit number, location, PCI, and rating of each sample unit inspected. The mean PCI for each feature was then calculated to determine the general condition or rating of the feature as shown in Figure C3. The U.S. Army Engineer Division, Pacific Ocean (POD) evaluated the airfield in 1981, however they did not report the results in terms of the PCI method for determining the surface condition of pavements. The results of the condition survey conducted by the POD in 1980 consisted of a general description of the airfield as being in excellent condition. Since all of the features of BAAF had been overlayed in 1979, it can be assumed that all of the features would have rated excellent in 1980. For comparison purposes a PCI of 100 was assigned to each feature for 1979 and this is compared to the results of the 1994 survey in Table C2.

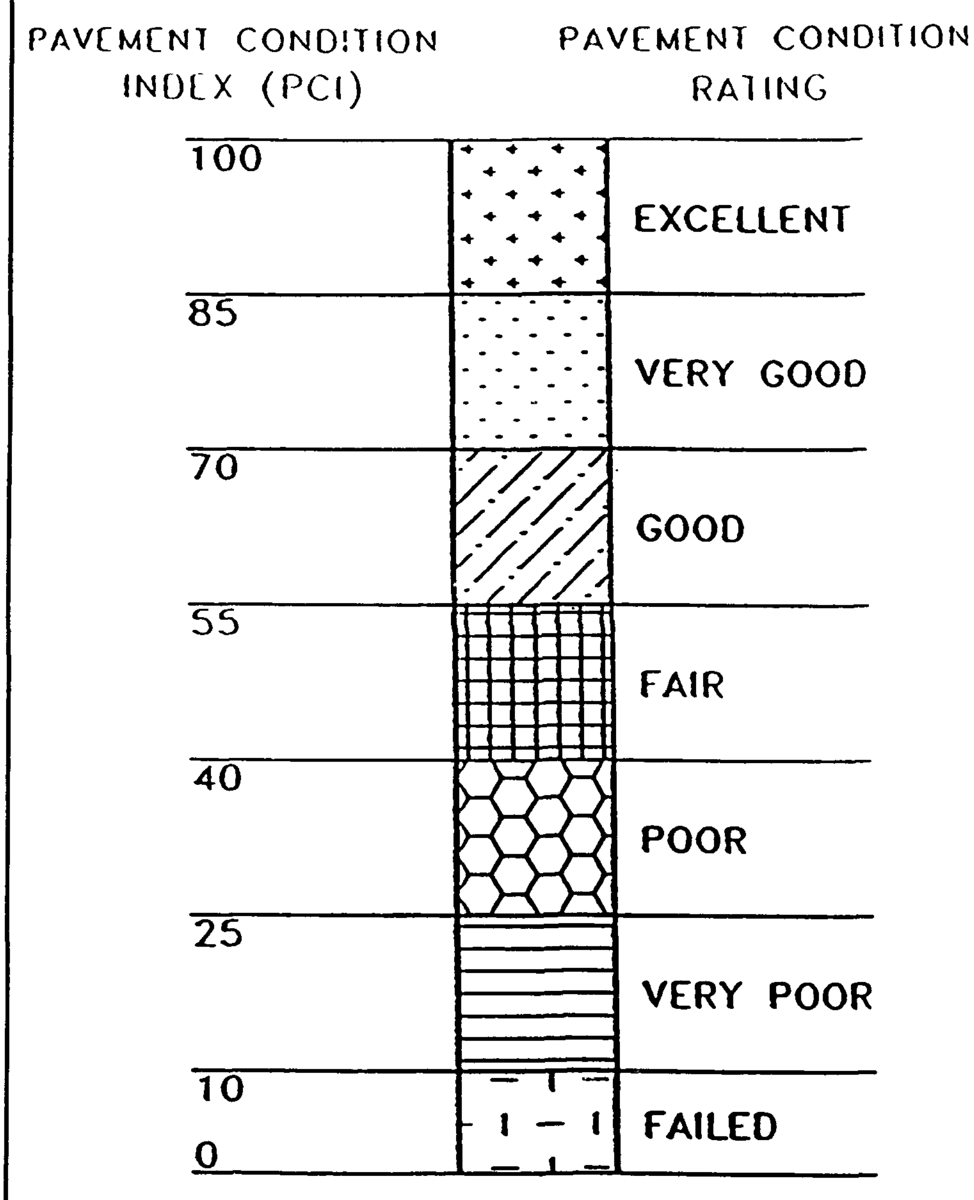

Figure C1. Scale for pavement condition rating

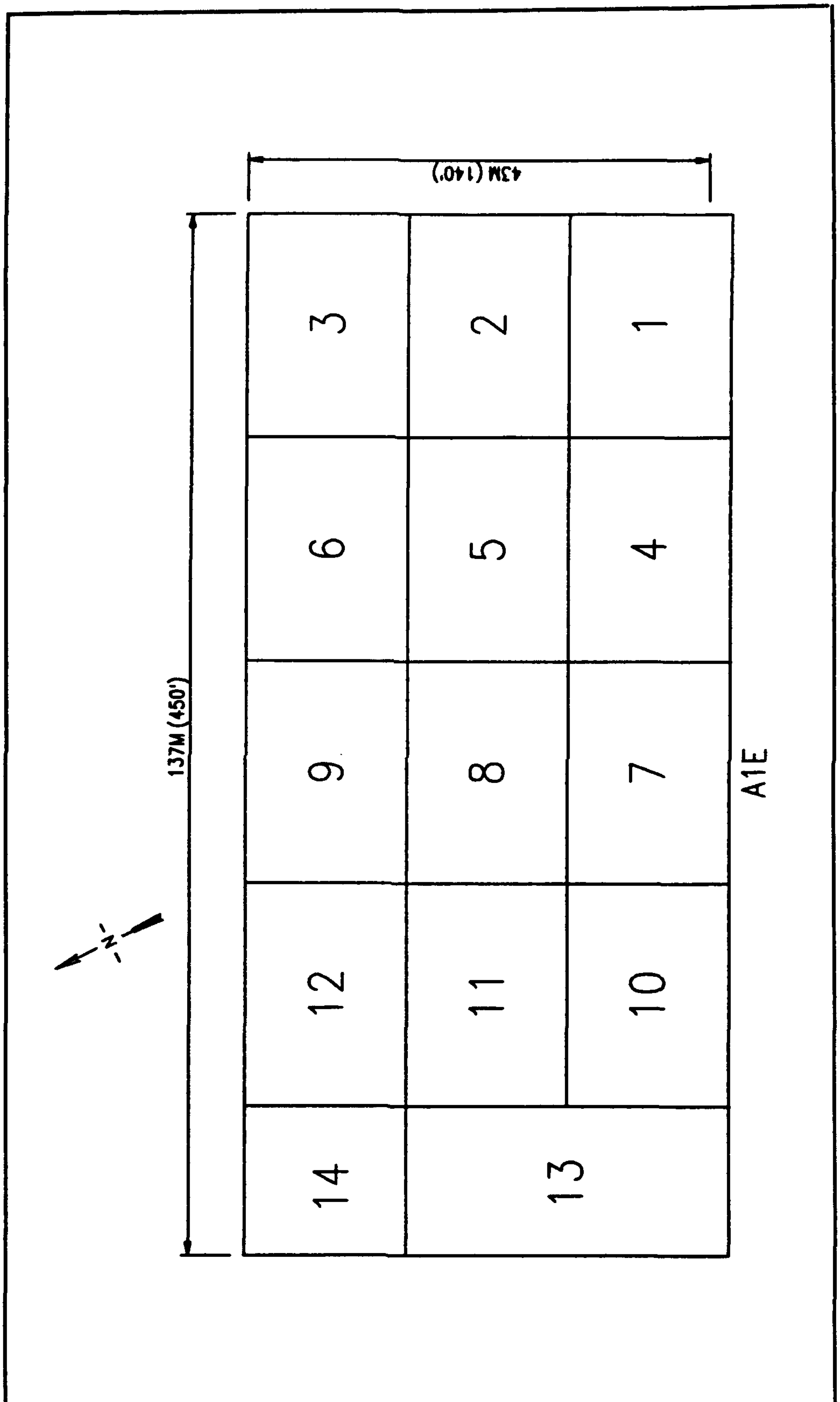

Figure C2. Sample unit layout, Apron

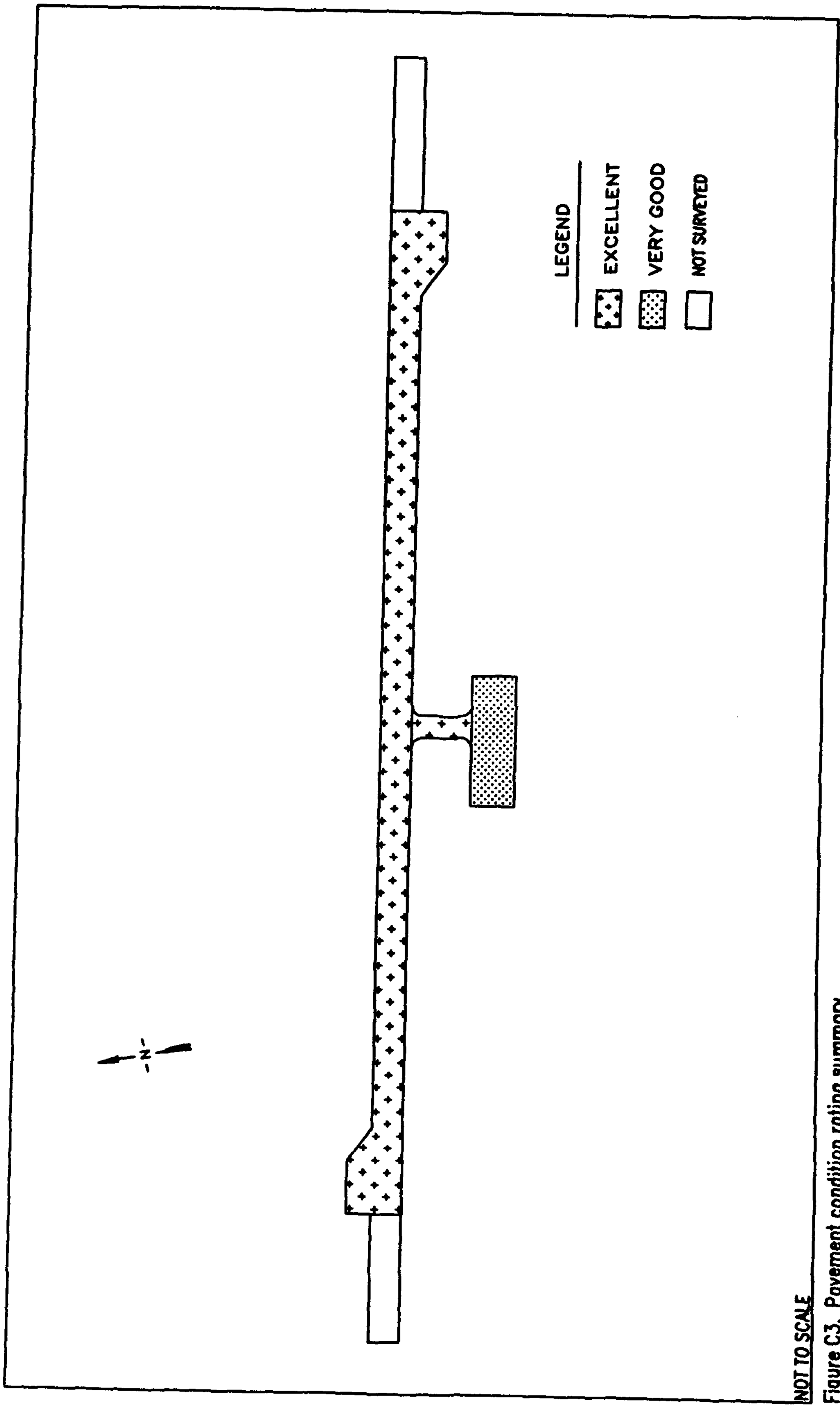

Figure C3. Pavement condition rating summary

Table C1
Pavement Condition Survey Results

Feature	Sample Unit	Station		PCI	Rating	Overall	
		From	To			PCI	Rating
R1E	1	0+00	1+00	98	Excellent	99	Excellent
	2	1+00	2+00	100	Excellent		
	3	2+00	3+00	100	Excellent		
R2E	5	4+00	5+00	97	Excellent	96	Excellent
	9	8+00	9+00	96	Excellent		
	13	12+00	13+00	100	Excellent		
	17	16+00	17+00	95	Excellent		
	21	20+00	21+00	96	Excellent		
	27	26+00	27+00	95	Excellent		
	31	30+00	31+00	95	Excellent		
	34	33+00	34+00	96	Excellent		
R3E	35	34+00	35+00	100	Excellent	100	Excellent
	36	35+00	36+00	100	Excellent		
	37	36+00	37+00	100	Excellent		
T1E	1	0+00	1+00	97	Excellent	98	Excellent
	2	1+00	2+00	100	Excellent		
A1E	1			85	Very Good	77	Very Good
	3			81	Very Good		
	5			84	Very Good		
	7			100	Excellent		
	9[1]			41	Fair		
	11			76	Very Good		
	13			76	Very Good		

[1] Sample unit number 9 of feature A1E contained a great deal of bleeding which caused it to have a much lower PCI rating than the other sample units surveyed in the feature.

Table C2
1979 PCI Compared with 1994 PCI

Feature[1]	1979 PCI (assumed)	1994 PCI	Change in PCI	1987 Rating	1993 Rating
R1E	100	99	-1	Excellent	Excellent
R2E	100	96	-4	Excellent	Excellent
R3E	100	100	0	Excellent	Excellent
T1E	100	98	-2	Excellent	Excellent
A1E	100	77	-23	Excellent	Very Good

[1] All pavement feaatures are AC.

Appendix D
Structural Analysis

General

The projected performance of the airfield pavement facilities was analyzed for a 20-year analysis period. The traffic for this period was based on the information provided by the installation. The critical aircraft operating on the pavements at BAAF was determined to be the 70,300 kg (155-kip) C-130 aircraft. The airfield was evaluated for 15,000 operations of the critical aircraft.

The operational ACN values were determined based on the critical aircraft; the 70,300 kg (155-kip) C-130 on the AC pavements. The results showing the ACN values for each pavement type and subgrade strength, are shown in Table D1.

During wartime, many aircraft are allowed to carry heavier loads than during peacetime. This means that the aircraft would have a higher ACN because of the higher loading and would cause more damage than in peacetime. This would reduce the life of the pavement. A mobilization ACN can be determined from the appropriate ACN-PCN curve presented in the draft ETL 1110-3-394 (Headquarters, Department of the Army 1991). The ACN-PCN curve for a C-130 on both flexible and rigid pavements are shown in Figure D1. During contingency planning, there is often the need to determine the largest possible aircraft that can safely land on the airfield. Generally the length of the runway controls this. Minimum take-off distances for maximum take-off weights of aircraft are also given in ETL 1110-3-394 (Headquarters, Department of the Army 1991). Once the aircraft is known, the ACN of that aircraft can be determined from the ACN-PCN curve and then the effect of the higher loads on the airfield can be determined from the ACN/PCN ratio and pavement life utilized or passes till failure curves. Specific aircraft mobilization traffic requirements are contained in classified mobilization plans and are not included in this report.

ACN-PCN Method of Reporting Pavement Structural Condition

The ACN-PCN method is used to provide a means of reporting the structural evaluation of a pavement. This procedure is a standardized International Civil Aviation Organization (ICAO) method. The ACN is used to express the effect of individual aircraft on different pavements by a single unique number which varies according to pavement type and subgrade strength without specifying a particular pavement thickness. Conversely, the PCN of a pavement can be expressed by a single unique number without specifying a particular aircraft. The ACN and PCN values are defined as follows:

a. ACN - A number which expresses the relative structural effect of an aircraft on different pavement types for specified standard subgrade strengths in terms of a standard single-wheel load.

b. PCN - A number which expresses the relative load-carrying capacity of a pavement for a given pavement life in terms of a standard single-wheel load.

The ACN-PCN method is structured so that the structural evaluation of a pavement for particular aircraft can be accomplished by using the ratio of the aircraft ACN to the pavement PCN. For a given pavement life and a given number of operations for a particular aircraft there is a relationship between the ACN/PCN ratio and the percent of pavement life used by the applied traffic. For a given ACN/PCN ratio a relationship exists for the number of operations that will produce failure of the pavement. This relationship provides a method for evaluating a pavement for allowable load depending on acceptable degree of damage to the pavement or an allowable number of operations of a particular aircraft to cause failure of a pavement. For aircraft having an ACN equal to the PCN the predicted failure of the pavement would equal the design life of the pavement. Aircraft having ACN's higher than the pavement PCN would overload the pavement and decrease the life of the pavement. Likewise if the ACN of the operational aircraft is less than the pavement PCN, the structural life of the pavement would be greater than the design life. If the operational ACN is greater than the pavement PCN and a decrease in pavement life is not acceptable, then structural improvement of the pavement is required to bring the pavement PCN up to or greater than the operational ACN.

Determination of CBR for Analysis

DCP tests were run at several locations at BAAF. Figures B2 through B9 show a plot of the CBR values versus depth obtained from the DCP tests. From Figures B2 through B9, it can be observed that the DCP calculated CBR is above the design CBR for each pavement feature with the exception of one of the DCP tests in feature A1E. The design CBR for each pavement layer is

80 percent for base course, 50 percent for subbase course, and 15 percent for high strength subgrades. Table D2 shows the DCP measured CBR and design CBR of each pavement layer for each feature evaluated. In order to provide a reasonably conservative evaluation, and be in accordance with the maximum values recommended in DM 21.3/TM 5-825.2/AFM 88-6 Chap.2, the CBR used for evaluation was the lessor of the DCP measured CBR or the design CBR. Features R1E, R2E, R3E and T1E were evaluated based on the design CBR. Feature A1E was evaluated based on the DCP measured CBR.

PCN Analysis

The PCN for each pavement feature was determined in accordance with TM 5-826-5/AFP 88-24 (Headquarters, Departments of the Army and the Air Force 1993). Using the design aircraft and traffic levels for normal operations the PCN was determined for each pavement feature. The PCN is determined using the allowable gross aircraft load and the subgrade strength category determined from the CBR. A typical ACN-PCN curve is shown in Figure D1. Table D3 presents a summary of the evaluation of each pavement feature in terms of allowable gross aircraft loadings, PCN, and overlays required to bring the PCN up to the required PCN (ACN of the design aircraft). The APEC presented in Figure 2-1 shows a layout of the airfield pavements and corresponding PCN for each facility.

Because all pavement features (with the exception of the overruns) had a calculated PCN greater than the required ACN, an analysis was not necessary to determine additional strengthening requirements to increase the PCN to equal the current ACN. If the PCN is less than the ACN, an increase in strength requirement is determined and reported as an overlay thickness. An overlay thickness required to provide a PCN equal to the ACN was reported for the overruns in Table D3. Although the increase in strength is presented as an overlay thickness, several other approaches could be used to increase the strength. A detailed analysis is required to select and design the most cost-effective repair or improvement alternative. It should be noted that minimum overlay requirements, if necessary, would be indicated in Table D3, the following minimum thicknesses are recommended:

a. 5 cm (2-in.)-thick minimum AC overlay over AC pavements.

b. 10 cm (4-in.)-thick minimum AC overlay over PCC pavements.

c. 15 cm (6-in.)-thick minimum PCC partially or nonbonded overlay.

d. 5 cm (2-in.)-thick minimum PCC fully bonded overlay over PCC pavements.

These minimum overlay requirements are required to control the degree of cracking which will occur in the base pavement (existing pavement) due to the application of the design traffic. If any feature required structural

improvements and did not receive the required strengthening, the rate of deterioration can be quite rapid leading to damage in all pavement layers. This will generally cause dramatic increases in the cost of later treatments after failure has occurred. It may also cause the pavement to be closed for operation for a considerable period of time.

The PCN codes for the weakest feature within each pavement facility during normal operations are shown in Table D4. The PCN codes include the PCN numerical value, pavement type, subgrade category, allowable tire pressure, and method used to determine the PCN. An example of a PCN code is: 30/F/A/X/T, with 30 expressing the numerical PCN value, F indicating a flexible pavement, A indicating high strength subgrade, X indicating medium-allowable tire pressure, and T indicating that the PCN value was obtained by a technical evaluation. Table D5 presents a description of all the letter codes comprising the PCN code. Each PCN assumes that only the design aircraft will be used for the stated number of passes. Once the PCN's were determined, relationships were developed for pavement life and allowable traffic as a function of the ratio of ACN to PCN. Theoretically, if the PCN is equal to or greater than the ACN, the pavement should perform with only routine maintenance through the length of the analysis period. There may be situations when operators have to overload a pavement, i.e., the ACN is greater than the PCN. Pavements can usually support some overload, however, pavement life is reduced. If the PCN equals the ACN, the ratio of the ACN to the PCN (ACN/PCN) equals 1.0, the pavement is expected to perform satisfactorily until the end of the analysis period. If the PCN is less than the ACN, ACN/PCN would be greater than 1.0, the pavement would be expected to fail before reaching the end of the analysis period. Figures D2 and D3 show the relationships for the allowable passes to failure if the ACN/PCN is known. Thus if the ACN for mobilization or the ACN for contingency planning divided by the current PCN is 1.5, failure would be expected to occur at between 800 and 1,200 applications for fixed wing aircraft on flexible pavements, based on Figure D2. An additional example of how the ACN/PCN figures are used is shown below.

Example Problem

A cargo mission has been assigned to the fixed-wing facility. Aircraft traffic is projected to be 500 passes of a 79,450 kg (175 kip) C-130.

a. What is the ACN for the aircraft?

b. Will the runway be overloaded?

c. How much of the pavement life will be utilized during this mission?

d. Determine the maximum number of C-130 passes before failure?

Solution

The controlling AC feature on the airfield is the apron, A1E. From Table D4, feature A1E has a PCN code of 27/F/A/W/T.

a. From Figure D1 the ACN of a 79,450 kg (175-kip) C-130 on a flexible pavement over a high strength subgrade is 24/F/A/W/T.

b. The ACN/PCN is 24/27 or 0.9; therefore the runway pavement will not be overloaded.

c. From Figure D3, the percent life utilized for a ACN/PCN of 0.9 and 500 passes is about 2 percent.

d. From Figure D2, the passes until failure for a ACN/PCN of 0.9 are about 20,000.

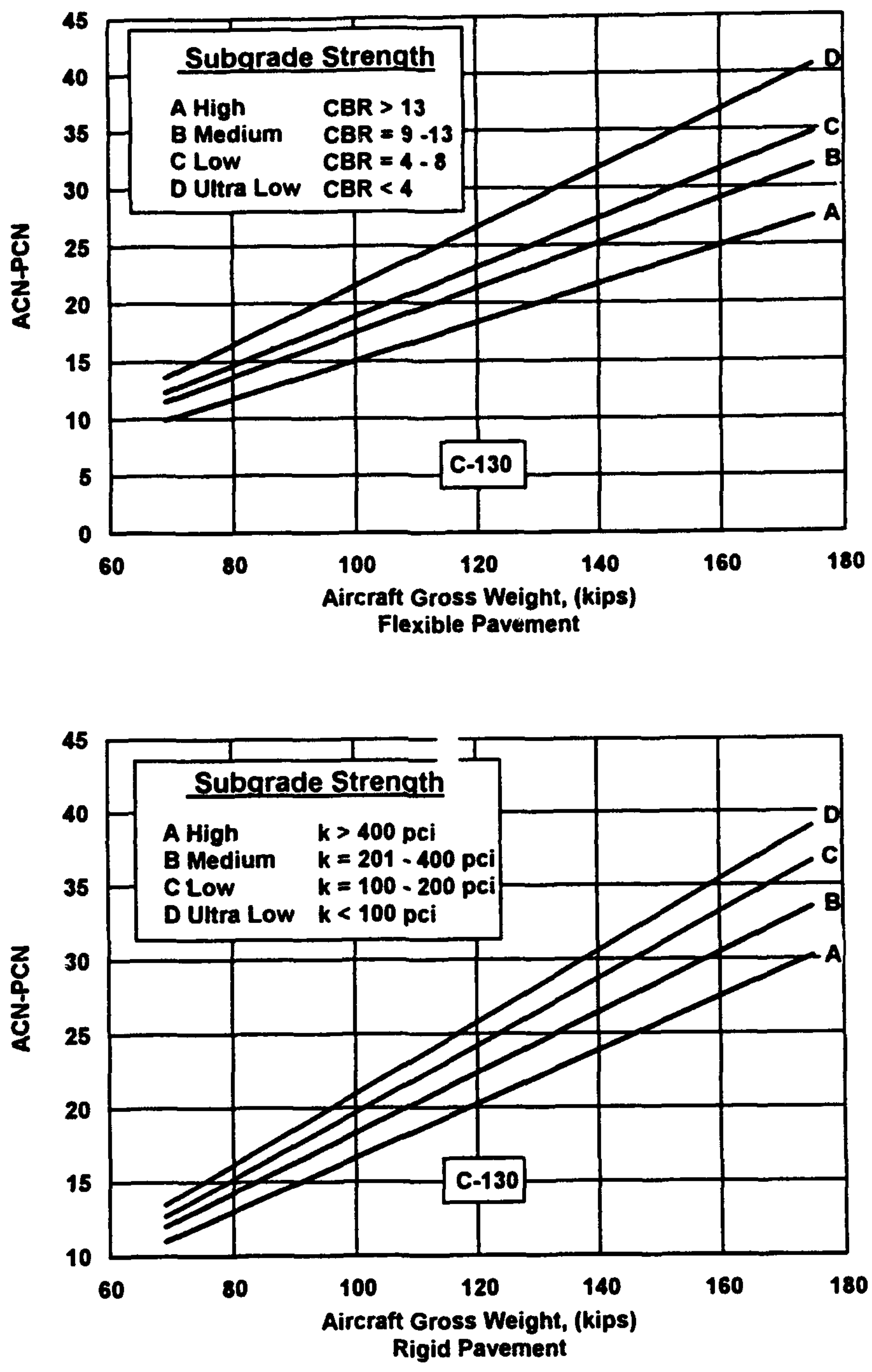

Figure D1. ACN curves for C-130 aircraft.

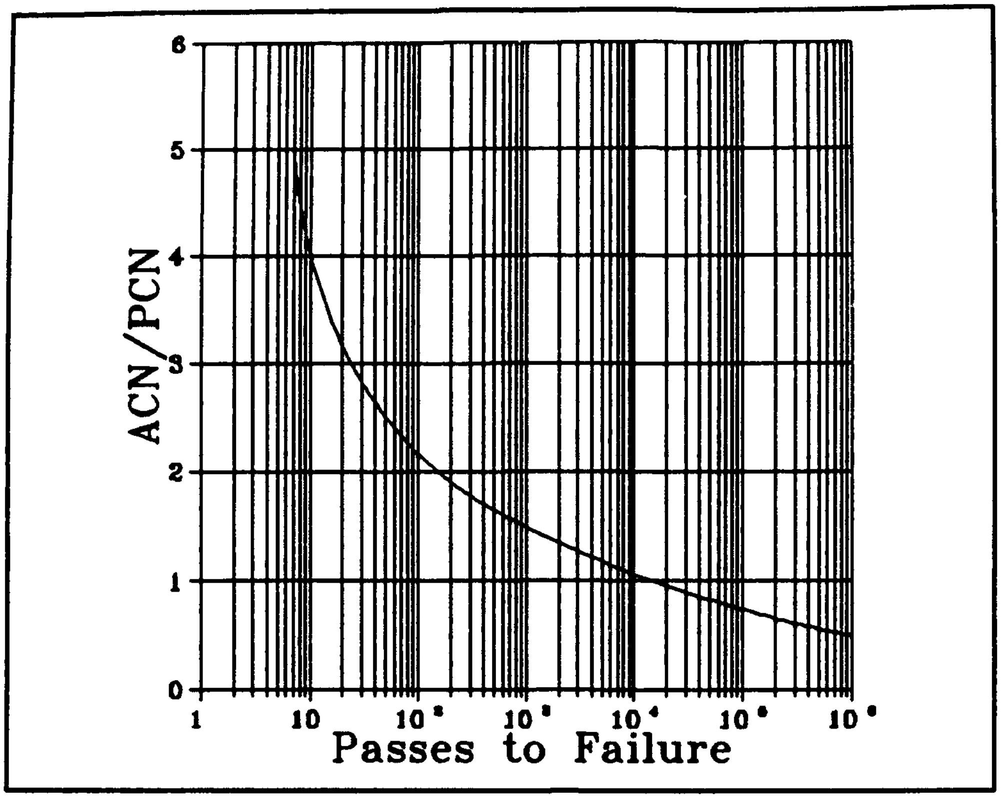

Figure D2. ACN/PCN versus allowable passes.

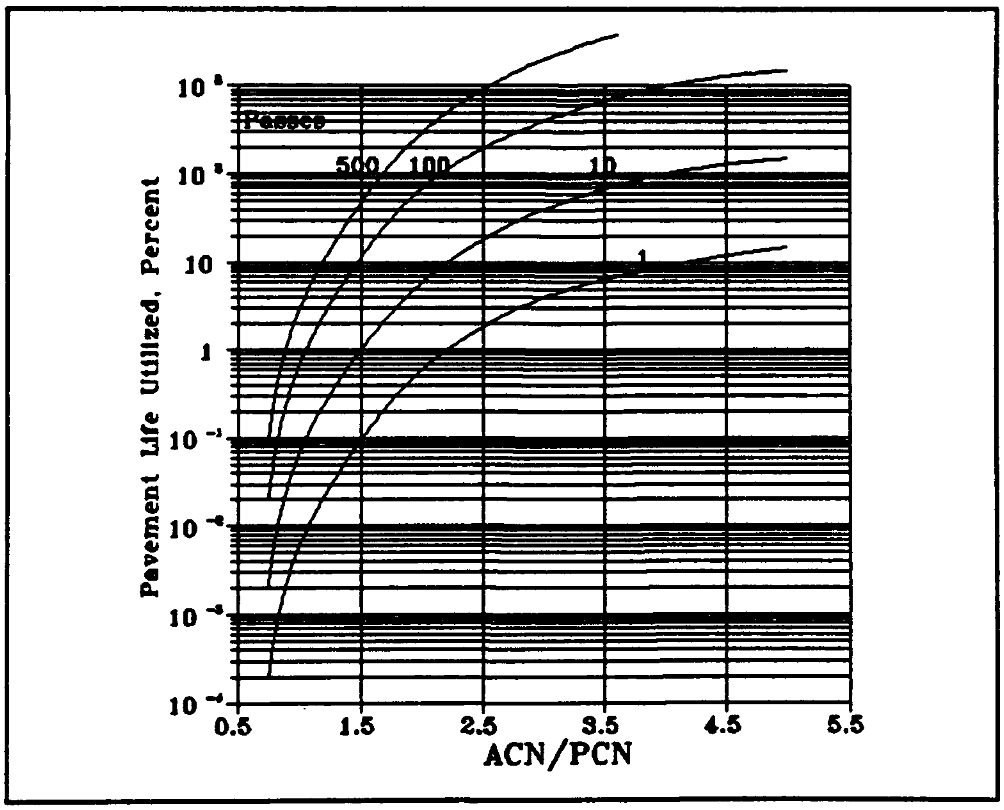

Figure D3. Percent life utilized versus ACN/PCN.

Table D1
Determination of ACN Values for Critical Aircraft

PCC Pavements			
Design Fixed-Wing Aircraft	**Weight kg (lb)**	**Subgrade Category[1]**	**ACN or Required PCN**
C-130	70,300 (155,000)	A B C D	27 29 32 34

AC Pavements			
Design Fixed-Wing Aircraft	**Weight kg (lb)**	**Subgrade Category[1]**	**ACN or Required PCN**
C-130	70,300 (155,000)	A B C D	24 28 30 36

[1] See Table D-4 for subgrade category.

Table D.
DCP measured CBR and Design CBR for Each Pavement Layer

DCP Test Location	CBR (percent)		
	Base Layer	Subbase Layer	Subgrade Layer
Runway, Station 5+00	100+	100+	---
Runway, Station 32+00	100+	100+	---
Taxiway, Station 1+00	85	85	50
Apron, Test 1	85	85	30
Apron, Test 2	60	35	35
09 End Overrun, Test 1	---	---	50
09 End Overrun, Test 2	---	---	50
27 End Overrun	---	---	65
DESIGN	80	50	15

Table D3
Allowable Gross Aircraft Loads and Overlay Requirements for Design Aircraft Traffic[1]

Pavement Facility	Feature	Type Traffic Area	Subgrade CBR Percent[2]	Operational ACN[3]	Allowable Gross Aircraft Load[3] Mg (kips)	PCN	Theoretical Overlay Requirements, cm (in.)		
							AC	PCC	PCC with Bond Breaker
Runway 09-27	R1E	A	15	24/F/A/W/T	+	36/F/B/W/T	0.0	---	---
Runway 09-27	R2E	A	15	24/F/A/W/T	+	36/F/A/W/T	0.0	---	---
Runway 09-27	R3E	A	15	24/F/A/W/T	+	36/F/A/W/T	0.0	---	---
Taxiway	T1E	A	15	24/F/A/W/T	+	36/F/A/W/T	0.0	---	---
Apron	A1E	B	15	24/F/A/W/T	75 (165)	27/F/A/W/T	0.0	---	---
09 End Overrun	---	C	50	24/F/A/W/T	38 (83)	12/F/A/W/T	9 (3.5)	---	---
27 End Overrun	---	C	50	24/F/A/W/T	38 (83)	12/F/A/W/T	9 (3.5)	---	---

[1] The day-to-day traffic is equivalent to 15,000 passes of a C-130.
[2] Values of CBR were calculated based on results from DCP tests.
[3] Determined for the critical aircraft.
\+ The allowable load is greater than the design aircraft load.

Table D4
Summary of Pavement Classification Numbers

Pavement Facility	Controlling Feature	PCN[1], Normal Non-Frost
Runway	R1E, R2E, R3E	36/F/A/W/T
Taxiway	T1E	36/F/A/W/T
Apron	A1E	27/F/A/W/T
Overrun	—	12/F/A/W/T

[1] Table D5 describes the components of the PCN code.

Table D5
PCN Five-Part Code

PCN	Pavement Type	Subgrade Strength[1]	Tire Pressure[2]	Method of PCN Determination
Numerical value	R - rigid F - flexible	A B C D	W X Y Z	T - technical evaluation U - using aircraft

[1]

Code	Category	Flexible Pavement CBR, %	Rigid Pavement k, MN/m³ (psi/in)
A	High	Over 13	Over 108 (400)
B	Medium	8 - 13	54-108 (201-400)
C	Low	4 - 8	27-54 (100-200)
D	Ultralow	< 4	< 27 (100)

[2]

Code	Category	Tire Pressure, kPa (psi)
W	High	No limit
X	Medium	1.0-1.5 (146-217)
Y	Low	0.5-1.0 (74-145)
Z	Ultralow	0-0.5 (0-73)

Appendix E
Micro PAVER Output Summary

INSPECTION REPORT

```
==========================================================================
Network ID      - WES
Branch Name     - APRON                          Section Length  -    450.00 LF
Branch Number   - A1E                            Section Width   -    140.00 LF
Section Number  - 1       Family - DEFAULT       Section Area    -  63000.00 SF
==========================================================================

  -------------------------------------------------------------------
  Inspection Date: FEB/24/1994
  Riding Quality :              Safety:       Drainage Cond.:
  Shoulder Cond. :       Overall Cond.:              F.O.D.:
  -------------------------------------------------------------------
  --------------------------------------------------------------------

  PCI OF SECTION =  77                            RATING = V. GOOD

  TOTAL NUMBER OF SAMPLE UNITS =     13
  NUMBER OF RANDOM SAMPLE UNITS SURVEYED      =     7
  NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED =     0
  RECOMMENDED MINIMUM OF     12 RANDOM SAMPLE UNITS TO BE SURVEYED.
  STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED =  18.0%

        *** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

  DISTRESS-TYPE    SEVERITY       QUANTITY        DENSITY %    DEDUCT VALUE
  42 BLEEDING       N/A          1852.94 (SF)        2.94             15.6
  48 L & T CR       LOW           491.03 (LF)         .78              4.5
  48 L & T CR       MEDIUM        932.03 (LF)        1.48             13.5
  49 OIL SPILLAGE   N/A            81.53 (SF)         .13              2.1

     *** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

  LOAD                RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
  CLIMATE/DURABILITY RELATED DISTRESSES =  50.43 PERCENT DEDUCT VALUES.
  OTHER               RELATED DISTRESSES =  49.57 PERCENT DEDUCT VALUES.
```

INSPECTION REPORT

```
==========================================================================
Network ID      - WES
Branch Name     - RUNWAY                         Section Length  -    300.00 LF
Branch Number   - R1E                            Section Width   -     90.00 LF
Section Number  - 1       Family - DEFAULT       Section Area    -  27000.00 SF
==========================================================================

  -------------------------------------------------------------------
  Inspection Date: FEB/24/1994
  Riding Quality :              Safety:       Drainage Cond.:
  Shoulder Cond. :       Overall Cond.:              F.O.D.:
```

INSPECTION REPORT

Network ID	- WES		
Branch Name	- RUNWAY	Section Length	- 300.00 LF
Branch Number	- R1E	Section Width	- 90.00 LF
Section Number	- 1 Family - DEFAULT	Section Area	- 27000.00 SF

Inspection Date: FEB/24/1994
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 99 RATING = EXCELLENT

TOTAL NUMBER OF SAMPLE UNITS = 3
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 3
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0
RECOMMEND EVERY SAMPLE UNIT BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 1.0%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
45 DEPRESSION	LOW	27.00 (SF)	.10	.3

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD RELATED DISTRESSES = .00 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY RELATED DISTRESSES = .00 PERCENT DEDUCT VALUES.
OTHER RELATED DISTRESSES = 100.00 PERCENT DEDUCT VALUES.

INSPECTION REPORT

Network ID	- WES		
Branch Name	- RUNWAY	Section Length	- 3400.00 LF
Branch Number	- R2E	Section Width	- 90.00 LF
Section Number	- 1 Family - DEFAULT	Section Area	- 306000.00 SF

Inspection Date: FEB/24/1994
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 96 RATING = EXCELLENT

TOTAL NUMBER OF SAMPLE UNITS = 34
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 8
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0
RECOMMENDED MINIMUM OF 5 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 1.4%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
48 L & T CR	LOW	1185.75 (LF)	.39	3.8

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

```
LOAD                RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY RELATED DISTRESSES = 100.00 PERCENT DEDUCT VALUES.
OTHER               RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
```

INSPECTION REPORT

```
Network ID     - WES
Branch Name    - TAXIWAY                        Section Length  -    250.00 LF
Branch Number  - T1E                            Section Width   -     55.00 LF
Section Number - 1       Family - DEFAULT       Section Area    -  13750.00 SF
```

```
---------------------------------------------------------------------
Inspection Date: FEB/24/1994
Riding Quality :              Safety:          Drainage Cond.:
Shoulder Cond. :      Overall Cond.:                 F.O.D.:
---------------------------------------------------------------------
---------------------------------------------------------------------
```

```
PCI OF SECTION =  98                              RATING = EXCELLENT

TOTAL NUMBER OF SAMPLE UNITS =     2
NUMBER OF RANDOM SAMPLE UNITS SURVEYED      =    2
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED =    0
RECOMMEND EVERY SAMPLE UNIT BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED =   2.2%
```

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
49 OIL SPILLAGE	N/A	13.75 (SF)	.10	2.0

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

```
LOAD                RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
OTHER               RELATED DISTRESSES = 100.00 PERCENT DEDUCT VALUES.
```

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12a. DISTRIBUTION/AVAILABILITY STATEMENT
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12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

An airfield pavement investigation was performed in February 1994 at Bradshaw Army Airfield, Pohakuloa Training Area, Hawaii, to develop information pertaining to the structural adequacy of the airfield pavements for continued use under current mission and the upgrading of the pavements for mission changes. The pavement surface condition was evaluated using the pavement condition index (PCI) condition survey procedure, and a nondestructive evaluation procedure was used to determine the load-carrying capability of the pavements and overlay requirements for continued use of the pavements under current missions. Results of the evaluation are presented including: (a) a tabulation of the existing pavement features, (b) the results of the nondestructive tests performed using a dynamic cone penetrometer, (c) the PCI and condition rating of the surface of each pavement feature, (d) a structural evaluation of each feature based on the projected 20-year day-to-day traffic, (e) the pavement classification number for each pavement facility, and (f) maintenance and repair recommendations based on the structural evaluation and condition survey.

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